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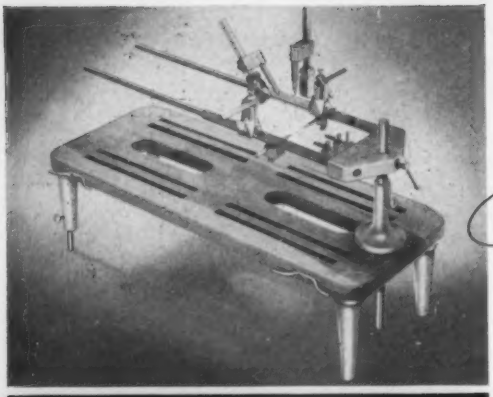

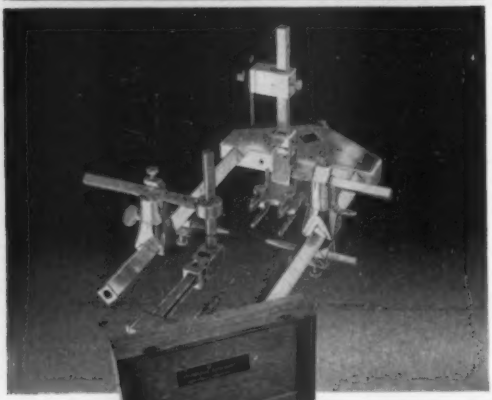

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Hazards of Nuclear Power Plants

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THE beneficial prospects associated with the development of nuclear energy have been widely publicized. On the other hand, discussions of some of the unpleasant aspects have been limited almost exclusively to technical meetings and publications. A realistic appraisal of the future of nuclear power must include consideration of the potential problems as well as the potential benefits. The discussion presented here (*1*) is focused on the hazardous conditions that could, under the most pessimistic assumptions, result from a major accident involving a nuclear power plant.

The three principal elements that must be considered together in order to establish a realistic overall perspective in any discussion of industrial hazards are (i) the types of accidents that can occur and the extent of property damage and personal injury that may be involved; (ii) the probability of occurence, and (iii) the positive benefits that may be balanced against the risks. Unfortunately, experience in the field of high-temperature, high-power nuclear plants is, for all practical purposes, zero. We can therefore, at this stage, discuss these matters only in very general terms, terms based in very small part upon the factual information and experience gained from the limited number of reactors that have been built and operated.

Reactors are not only expensive machines; they are also potentially hazardous machines, substantially more so, in fact, than any industrial machines with which we are currently familiar. This of course does not mean that reactors will not eventually be used industrially with risks comparable to those associated with other industrial machines. It does mean, however, that a much greater degree of caution and control must be exercised in their design and operation; and it means that safeguards, perhaps costly, must be provided in the design of plants if the industry is going to develop and play a major role in our national economy. In the absence of realistic information based upon experience, those concerned with the design of nuclear power plants and those responsible for their operation must make the most pessimistic assumptions with regard to potential accidents and their consequences. In view of the potential seriousness of the off-site hazards, it is reasonable to place the burden of proof to do otherwise upon the sponsor of the plant. With experience will come effective and practical methods for dealing with these problems.

Remember that this discussion concerning the maximum possible reactor accident and the present evaluation of the maximum damage and hazard that can result from such an accident is only one part, the negative part at its worst, in the over-all consideration and evaluation of nuclear power plants.

Two principal characteristics of a nuclear power plant allow us to conclude at the outset that we are dealing with a highly hazardous operation: (i) the contained radioactive materials, fission products, and some types of fuel used, and (ii) the fact that the plant will contain, under certain circumstances, considerably more fissionable material than the critical amount. The significance of the combination of these two factors can be appreciated in some small measure if we compare the situation with, say, large-scale production of both highly poisonous gas and explosives under the same plant roof.

Fission products are produced by the reactor fuel in the process of consumption. They are therefore unavoidably tied to the generation of nuclear power. For example, a plant generating 10,000 kw will produce about 200 lb of fission products in the course of a year. The fission products are highly radioactive and therefore, like the more familiar material radium, can produce serious injury or death. Fission products, which include a large variety of chemical elements, if inhaled or ingested are from 3 million to 2000 million times more toxic than chlorine, the most potent common industrial poison (*2*).

Two other characteristics further differentiate the potential hazard of fission products from more conventional industrial poisons: (i) they cannot be detected by the senses, even in lethal concentrations; and (ii) nonlethal exposures can produce permanent injuries that may not become evident until many years after the accident. In addition, the nuclear fuels themselves, plutonium and uranium-233, are highly toxic if inhaled or ingested.

I now come to the second principal characteristic of a nuclear power plant, which is its built-in capacity for self-destruction in an exceedingly short time—in a fraction of a second. This characteristic derives from the fact that the reactor core will, under certain circumstances in its operating life, contain substantially more fissionable material than the critical amount required for a chain reaction. This situation suggests the possibility of a runaway condition with a rapidly accelerating chain reaction and with a simultaneous rise in temperature.

If a reactor does get out of control its power output and temperature can rise very rapidly to the point where the nuclear reaction is stopped by either one or a combination of two effects: disruption of the reactor core, or melting or vaporization of the nuclear fuel. The best calculations of expected blast effects from a runaway reactor under the worst cir-

cumstances show that it would be relatively small (*3–6*). The blast could certainly damage the reactor and its associated equipment beyond repair, but outside of the reactor building its direct effects would be negligible.

Before describing the maximum possible nuclear power plant accident, I want to emphasize that the probability of having such an accident will depend largely on such factors as the over-all design of the reactor and plant and the competence of the operators. Measuring instruments are available to detect hazardous conditions if they should arise, and controls and safety features are designed to nip them in the bud. However, if we are to appraise in general the potential hazards of nuclear power plants, we must assume that a runaway situation can be provoked, and we must examine the consequences under the most pessimistic conditions that might arise. Edward Teller, a member of the AEC's Advisory Committee on Reactor Safeguards, has said (*3*, p. 632):

> With all the inherent safeguards that can be put into a reactor, there is still no foolproof system that couldn't be made to work wrongly by a great enough fool. The real danger occurs when a false sense of security causes a let-down of caution.

The maximum possible accident can be considered along the following lines. Suppose that the nuclear power plant has been operating for a relatively long time without change of fuel; this means that a substantial amount of long-lived fission products has been produced and is contained in the core. In the course of start-up of the plant from a shutdown condition the nuclear reaction may get out of control; then the power output would increase at a rate that doubles its level every thousandth of a second, and the fuel temperature would rise accordingly. In a fraction of a second the fuel is melted and vaporized, chemical reactions take place between materials in the reactor core, and the rapid formation of gaseous products creates an explosion that damages the reactor structure and releases the radioactive fission products to the environment.

What damage has been done and what may further result? The reactor portion of the plant has been destroyed beyond repair. The building and a good deal of equipment have been contaminated with radioactivity and cannot be salvaged. Any operating personnel in the neighborhood of the reactor might have been injured or killed by blast damage at the time of the accident and, in any case, would have been exposed to the lethal properties of the radioactive materials released from the reactor. We assume that when the reactor structure is ruptured by the blast a large fraction of the fission products, perhaps 50 percent, is released in the form of a cloud that escapes from the reactor building into the overlying atmosphere. The radiation from this cloud would be lethal to a large fraction of the plant personnel, who could not be evacuated in the short time between the accident and appearance of the cloud. There might be fallout of radioactive material from the cloud, which would seriously contaminate the whole plant area.

The future course of events and the extent and type of damage and injury inflicted depend largely upon the local terrain and upon the meteorological conditions at the time of the accident. In line with taking the pessimistic position I will assume that the cloud remains close to the ground as it drifts slowly away from the plant with a prevailing wind of 3 to 4 mi/hr; that it passes over populated areas; and that an hour after the accident a rainstorm arises while the cloud is passing over farm land, over drainage areas that provide the local water supply, and over residential and industrial areas.

As a consequence of this assumed course of events the following injury and damage could result beyond the plant area (*5, 7–9*): (i) People in the path of the cloud within a distance of several miles from the plant could receive lethal doses of radiation. For example, this distance might be 5 or 6 mi for a 100,000-kw plant. (ii) If the cloud in its motion actually touched the ground, as would be the case under certain meteorological conditions, the distance within which people would receive lethal exposures as a result of inhalation would extend out substantially farther than it would if radiation from the cloud at a height of 50 or 100 ft were the only source of hazard. (iii) People exposed to the cloud and located at distances beyond the lethal radii for irradiation or inhalation would receive varying degrees of temporary or permanent injury. (iv) In the areas of rainout there would be widespread serious contamination—sources of food and water would be lost; population would have to be evacuated for an extended period from industrial, business, and residential areas. (v) Finally, not to be discounted are the many individuals who would be obsessed with continuing anxieties about their fate, even though they had sustained no observable injury at the time of the accident.

I have described a local catastrophe resulting from a nuclear power plant accident on the basis of a compounding series of pessimistic assumptions. I would now like to turn to some of the precautionary measures that can be taken in plant design, location, and operation to reduce the potential hazards of nuclear accidents. It should be noted that each of these measures can involve a substantial increase in over-all plant cost, operating expenses, or both. Their practicability therefore will be determined by a balance between their effect on the cost of the power generated and their effect on the cost of insurance if greater risks are accepted. Some of the obvious measures that can be taken are briefly as follows: (i) Select the basic reactor design that is inherently the most stable. There is a wide range of variation among reactor types. (ii) Locate the plant in a remote, unpopulated, unproductive area. This would clearly be impractical for a nuclear power industry. (iii) Locate the plant on a site large enough so that the risks of off-site damages and injuries are substantially reduced. Since land costs are high in industrialized and populated areas, the increase in fixed charges on the plant could easily price the power out of competition. (iv) Since the blast damage at the time of an acci-

dent is manageable, it is considered feasible to design the reactor building to be gastight and to contain any gaseous fission products released from the reactor. This general approach is the most promising. (v) In reactors using liquid fuels one can consider continuous removal of the fission products. This is probably practical and economical up to a certain point, beyond which the additional operating costs would become prohibitive. (vi) Construction of a widespread warning system and means for rapid evacution or sheltering of people in the path of the cloud.

These are some of the positive measures that can be taken to minimize the risks. There are other elements that can strongly influence the degree and extent of the hazards associated with a nuclear accident. These elements were all introduced as pessimistic assumptions in my description of the maximum possible accident. The considerations that tend to temper somewhat the harsh effects produced by deliberate compounding of pessimism include these: (i) The wind could carry the cloud over less heavily populated and sensitive areas than those assumed. (ii) The wind could be strong and the atmosphere turbulent. This would rapidly disperse the cloud and dilute its concentration. Although it would allow less time for evacuation, the hazards would extend over a substantially smaller area and the people would be exposed to the maximum radiation over a shorter period. (iii) A considerably smaller fraction of the fission products might be released into the atmosphere at the time of the accident. (iv) There would not necessarily be any fallout or rainout.

As a closing thought I would like to recapture a little of the over-all perspective that is all too easily submerged in a discussion focused on accidents and hazards. An important step in the development of any new process for large-scale industrial use is an understanding of possible abnormal, as well as normal, behavior of the equipment and an appreciation of the consequences in the event of malfunctioning. Only with this basic understanding of the process under all conditions can effective steps be taken to minimize the risks. In every field understanding leads to control. We now believe that we understand reactors. There will, of course, always be some risks, but the past 12 yr of safe activities with many different types of reactors is convincing testimony to our understanding of the technology and encourages us to believe that the problems of the future can be met with equal success.

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Need for Public Understanding of Science

Gerard Piel

Scientific American, New York, N.Y.

IT would be difficult, I am sure, to work up a debate in this company* on the question whether the American people ought to have a better understanding of science. No one present would want the negative side of that argument. When it comes to ignorance, we are all likely to sound like Calvin Coolidge's preacher on the subject of sin; we are against it.

We can congratulate ourselves, nonetheless, for our unanimity on this question. Not so long ago there was a respectable body of opinion in science which held that what the people don't know won't hurt them. A little knowledge is a dangerous thing, the argument ran; let the shoemaker stick to his last. Decisions on technical matters, whether in public affairs or in industry, ought to be made by experts qualified to deal with the hard and often complicated facts. The less such questions get embroiled in the misconceptions and prejudices of half-informed laymen, the better for everyone.

Admittedly, something of a case can be made for this point of view. I have not done justice to it as it was argued to me by a distinguished chemist some 15 years ago when I asked for help on an article for the lay public. Perhaps he is present here tonight. Perhaps, to borrow a troublesome metaphor, I should have let sleeping dogs lie!

Since we might have a debate after all, let me dispose of my honorable opponent's position right now.

* This paper is based on a talk given at the southeastern regional meeting of the American Chemical Society in Birmingham, Ala., 21 Oct. 1954.

I will concede the logic of his argument. But I call your attention to his unspoken premise and its essential weakness. This is the notion that an orderly and successful society is one which keeps people in their places. Along with much of our chemistry, this notion is an import from the hierarchical, authoritarian culture of Imperial Germany. It did not serve Germany particularly well, nor did it find hospitable soil in this country.

Since I have exposed the opposition's unspoken premise, it is only proper that I should confess my own. I am committed to the proposition that the wisdom of any government increases in direct ratio with the breadth, depth, and intensity of the public discussion that surrounds it. Democracy is not government by plebiscite. The role of the people does not stop at the ballot box. The health and vitality of a democratic society depends on the participation at all times in its decision-making of citizens who are concerned and who keep themselves informed.

Behind this premise there is another one. The argument in favor of the democratic process does not conclude with proof that republics are inherently wiser and stronger than dictatorships. This is incidental to the attainment, or the approximation, of the principal objective for which men organize democratic governments. That objective is to secure for each citizen the opportunity to realize, to the full the promise of his endowment as a man. The better-informed man is thus not merely a better-informed voter; he is above all a better-informed man. In the 18th century tradition, the perfectibility of man represents an end in itself.

Since it is chemistry that brings us together here, we may share a parochial satisfaction in recalling that the Founding Fathers put science high in the syllabus of learning that is to lead on to perfection. Thomas Jefferson equated the increase and the dissemination of scientific knowledge, the laboratory and the press, as the principal vessels of progress:

> While the art of printing is left to us, science can never be retrograde; what is once acquired of real knowledge can never be lost. To preserve the freedom of the human mind then and freedom of the press, every spirit should be ready to devote itself to martyrdom; for as long as we may think as we will, and speak as we think, the condition of man will proceed in improvement.

We are agreed, then, on the need for a wider understanding of science. Let us now attempt an estimate of that need. That is to say, let us see how far short of the ideal the present state of public understanding falls.

From this point, it would be easy to give over the rest of this evening to the misunderstanding of science. There is evidence to paint as dark a picture as the mood requires. Anton J. Carlson, the dean of American physiologists, is a generous man and a friendly critic. Yet he once declared that 20th century man somehow manages to survive in his man-made landscape just as ignorant of science and as haunted by superstition as Peking man in his unspoiled, primeval landscape of 100,000 years ago.

With due respect for the warmth of Carlson's feelings, I do not think we need to take as dim a view as he did. The truth is that dryads, leprechauns, and trolls have long since fled a culture that prizes oil burners, television sets, internal combustion engines, deep freezers, and all the other devices that ease and complicate our existence. These inanimate gadgets, animated only by the mechanics' tools, have generated a powerful antidote to the pathetic fallacy of animism that once populated the universe with the creatures of man's fear and imagination. Almost everybody now has acquiesced in the Copernican revolution and the displacement of our earth and us from the center of the universe. There is general recognition of the idea that the cosmos is a vast impersonal system, ordered by laws of mechanics. The germ theory of disease brings people to their doctors, not to their knees. In our law there is increasing acceptance of the idea of the criminal as a victim of psychological and sociological handicaps, an object for treatment not for vengeance. In the relationships of man to man, our fellow citizens are agreed that all men are members of the human race, and they expect that we will eventually learn to act like members of the same human family.

It is extremely doubtful that we could have found such wide acceptance of the rational and scientific view among the members of any previous generation. If we go back just a little way in history we find the world of reason confined to much narrower quarters by superstition, fear, and old wives' tales. Without doubt, future historians will conclude that it was during our lifetime, in the popularization of the rational outlook upon the world among citizens in all occupations and professions, that science had its greatest impact upon the life of mankind.

The ground still held in men's hearts by fear and superstition is thus narrowed. But on many of the most important questions of life, it seems to remain the decisive ground. Ironically, science itself seems to have fallen heir to much of what remains of the frightened awe formerly accorded to the outer darkness. There is reason enough to be troubled about public ignorance of the scientific and technical considerations that bear so heavily on the social and political issues of the day. But we have cause for more serious concern in the real misunderstanding which prevails in our culture about the nature of science as a human enterprise.

Science still occupies the House of Magic in which it was exhibited at the New York World's Fair in 1939. In the popular view science is first of all our most securely established body of knowledge. It is a rich mine of hard facts that have a tougher consistency and more utility than revelation. How these facts originated and got put together, nobody inquires. The notion that they might go on growing in number is disturbing to a large number of people. They raise the question whether there shouldn't be a law or a moratorium or a breathing spell. Scientists are workers in this House of Magic. They are qualified by special gifts—today, of course, they must also be

cleared—for access to technical information. Their job is to make something useful out of the ready-to-hand facts. Science is thus primarily an important step in the immense technological process that makes our country so rich and strong. The suggestion that science has cultural as well as technological implications is downright suspect and heretical, if not worse.

I believe you will agree that this is a fair rendering of the image of science as it is held in the public eye and mirrored in our press. It is something more than a merely popular image. It presents its most alarming aspect as it is accepted among otherwise educated members of our society. It contributes to the antirational, antiscientific mood presently ascendant in our culture. It promotes the almost complete estrangement of arts and letters from the sciences, which explains why our humanists largely miss the insights science now offers into so many of their habitual concerns. It is found even among engineers and scientists, who are all too often ignorant in fields outside their own, and among them it tends to confirm a sterile insularity that shirks the cultural and social responsibilities of their profession.

We can easily see, in principle, that such misunderstanding of science in our society presents serious hazards to both science and society. Let us now go from the general to the particular. By examining an actual instance of the effects of ignorance on public policy, we may take a real measure of the peril that confronts scientists and citizens in our country today. I would like to explore the murky controversy that presently embroils the military policies of our Federal Government.

The age of science dawned in the public consciousness in the apocalyptic summer of 1945. Neither generals nor privates in the ranks, cabinet ministers nor defense plant workers—no one was prepared to comprehend the instant annihilation of two Japanese cities. Here was a discontinuity in the steadily increasing horror of war, an abrupt ascent in man's capacity for destructive action.

The atomic bomb was, of course, a straightforward and logical extension of two generations' work in modern physics. Scientists of all of the nations that had scientific establishments had contributed to this work. But nobody had paid any attention to what the physicists were doing. All of the fundamental knowledge required to fashion not only a fission but a fusion bomb was in the public record before 1940. But nobody except physicists had read the literature.

The openness and completeness of the literature available deserves emphasis. Until the scientists of the Allied Nations imposed their own voluntary blackout late in 1939, there had been no occasion and no effort to conceal this work, even that concerning the unexpected discovery of nuclear fission. The January 1940 issue of *Reviews of Modern Physics* carried a survey article by Louis Turner of Princeton University that rounded up the papers on uranium fission then already in print. His bibliography begins with the first report, in 1934, by Enrico Fermi of his exposure of uranium to bombardment by slow neutrons. At this juncture, Fermi and his associates were looking for the then hypothetical transuranian element 93. They published two more papers that year. Their work stimulated interest in other countries. In 1935 seven papers are cited in the field, in 1936 five papers, in 1937 five more, and in 1938 nine papers. Then came the Hahn-Strassman-Meitner work, which developed the true import of Fermi's original experiment. As an index of the speed of communication within the tiny community of physics, Turner's bibliography showed 104 papers published in the year 1939. The bibliography listed contributions from the laboratories of a dozen nations. Out of a total of 133 papers cited, incidentally, a scant half-dozen bear the names of American authors, none of them dated earlier than 1939.

Turner's review article was reviewed in turn in a chapter on nuclear fission incorporated in a standard college physics textbook written by Ernest Pollard of Yale University published in 1940. With the aim of stimulating student interest, Pollard went beyond the formal presentation of the scholarly journal to speculate on the prospect of nuclear reactors that might generate electrical power or detonate as immensely destructive bombs, that might produce radioactive substances for research and industrial processes or for an appalling new kind of chemical warfare.

At the time of the Fermi-Dunning experiment at the Columbia cyclotron early in 1939, even the metropolitan press carried journalistic accounts that developed the spectacular implications of the work. But, again, nobody was the wiser. It was not only the celebrated man in the street who missed the point, but people who should have known better. That includes chemists, too. I remember that one of your leading journals, at about this time, was featuring a series of fanciful letters from its readers, satirizing the quantum theory. It was essentially a jursidictional dispute. A few physicists had presumed to apply quantum notions to a reinterpretation of the chemical bond. Physics, in truth, seemed to be dealing with a "world that is not only queerer than we imagine, but queerer than we can imagine."

As a direct consequence of this void in communication, the atom made its debut in our culture and in our polities as a military secret. The Atomic Energy Act of 1946 gives a measure of the ignorance, and hence the fear, that has engulfed the whole subject ever since. In its section on secrecy, the act gives atomic secrets a peculiar definition. It declares to be restricted

> . . . *all* data concerning the manufacture or utilization of atomic weapons, the production of fissionable materials or the use of fissionable materials in the production of power, but shall not include any data which the Commission from time to time determines may be published without adversely affecting the common defense and security.

In literal translation, this language means that the existing world literature of modern physics, including the 133 papers published before 1940, is declared to

be secret until such time as the Atomic Energy Commission might decide to declassify it. This is not secrecy in the only intelligible meaning of the term. It is statutory tabu. Like the tabu of the Polynesian cultures, it derives its sweeping sanctions from popular ignorance.

Herbert Marks, the first general counsel of the Atomic Energy Commission, observed in an article in the *Yale Law Journal* published in 1948 that the administration of the atom from the outset was walled off from the normal processes of "public scrutiny and protest" that are "the chief protections of society against incompetence, unfairness and corruption in government." Today, 9 years later, the tabu still throws its pall over all the immense questions of policy that are involved in the atomic energy enterprise. Among these, the most immediately decisive for the national security and welfare is the role of atomic weapons in our national defense program.

It is only during the last few months that the public has been given a chance to comprehend the extent to which our armament program is committed to big bombs. The *schrechlichkeit* theory of modern war, which rests upon the long range aerial destruction of civil populations, did not work in World War II. The hydrogen bomb may very well have made it the strategy of choice for World War III. But there has been no adequate public discussion of its soundness as a policy for our country. Certainly the debate on the question has fallen far short of our traditional standards of controversy on questions of such political, ethical, and military magnitude.

There was one brief moment, way back in 1948, when the possibility of an alternative military policy was actually debated in the public record. It was occasioned by interservice rivalry and the Navy's effort to preserve its independence within the unified military establishment. According to our native custom, the issue was the popular one of corruption—the question whether the first contract for intercontinental bombers had been properly negotiated by the Air Force. The transcripts of the Congressional hearings that followed are worth reading today. It is the last time that the public record rehearses the arguments in favor of a balanced military establishment designed to destroy enemy military forces and to take and to hold enemy territory.

I do not pretend to be qualified to make a judgment as to the choice of alternatives here. What seems to me more important and worth careful consideration by all responsible citizens is the fact that the decision was made in secret. It was made by a very few men. In making it, they did not have the advantage of the guidance—nor the disadvantage of the pressures—under which our public officials normally make such decisions. Since this is a procedure diametrically at odds with our custom and tradition, we are fortunate now to have at least part of the story in the public record. It is told in the current best-seller of the Government Printing Office, the 992 pages in small type entitled, *In the Matter of J. Robert Oppenheimer, Transcript of Hearing Before the Personnel Security Board of the United States Atomic Energy Commission.* The H-bomb controversy takes up roughly one-third of the million words. It is worth reading for the lesson in elementary civics which it holds.

Here you will find a story of palace intrigue that affronts the traditions of our self-government. The cast of characters includes scientists, lawyers, businessmen, and politicians—a representative sample of American officialdom. For each of them the immense burden of the decision that must be made is many times multiplied by the fact that it must be done in secret. It is clear from the record that no one is immune to the dread anxiety that his choice, whichever way it goes, may later be regarded as wrong. From the scientists on the General Advisory Committee to the politicians, however, you find an increasing tendency to play it safe, to decide that right will be on the side of the biggest bang. It is at this point, of course, that the public would normally be consulted and the responsibility for the decisions, right or wrong, laid where it belongs.

That was not possible here. Accordingly, what should have been questions of merit become questions of motive. Honorable men are impugned in the record of secret intelligence agencies. There is a poison pen letter. One imagination, made fertile by fear, invented a tale of a secret conspiracy of scientists, with a cabalistic code name, that is worthy of science fiction.

This is clearly not the way government is conducted in America. We may hope that the whole issue, now that the only significant security restraints have been breached by the very publication of the Oppenheimer transcript, will be subjected to public review and reconsideration.

Meanwhile, the obsession with secrecy and the ignorance of science from which it springs have done grave damage to the relationship between science and government and hence to the national security that military security procedures are supposed to protect. Recently, before a Congressional Committee, Vannevar Bush declared that the mutual respect between the scientific community and the military services achieved during World War II has been "almost destroyed and one of the principal reasons is the security system." As a result, he said the U.S. defense against continental air attack has fallen 2 years behind where it should be.

For the long-run good of science and the national welfare, this estrangement of scientists and the military might prove to have some advantages. In the present fiscal year the combined expenditures of the defense establishment and the Atomic Energy Commission, adding up to $1.2 billion, account for fully half of all the funds the nation is expending on research and development. The appropriation for the National Science Foundation in this same fiscal year is a mere $8 million. The contrast between these two figures is a measure of the continuing neglect in our country of the needs of fundamental research, or pure

science, as contrasted with our lavish expenditures on applied science.

Before the war basic science got one dollar in every six of the country's annual expenditures on research and development. If we add to the National Science Foundation's outlay the full income available from nonprofit foundations and university endowments and credit a generous portion of industry's research expenditures to the account of basic science, the biggest figure we can arrive at is about $120 million. This means that basic science today is getting not more than one dollar out of every twenty.

We have here a cold statement in dollars of the prevailing misunderstanding of the nature of science as an essential enterprise of our culture. This imbalance in emphasis on applied as against pure science has prevailed now for nearly 15 years, ever since American science was mobilized for World War II. Irreparable harm, in the opinion of many observers, has already been done to our scientific resources. The careers of a disproportionate percentage of a whole generation of younger scientists have been diverted to the narrower ends of applied research. Our high schools and colleges, with the offspring of the wartime baby boom on the verge of flooding their classrooms, see their science teachers going off to work as technicians, at higher salaries in industry and government.

By now the crucial relationship between pure and applied science ought to be comprehended by the public and the government. The story has been told over and over again. Ten years ago the original prospectus for the National Science Foundation declared:

> Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science.

It is further a familiar fact that America has made "less than its proportionate contribution to basic science." As Crawford Greenewalt put it,

> We have been fortunate in the past in having available to us the results of basic science from the world at large. This has permitted us to indulge our industrial genius, perhaps without at the same time contributing our fair share to the world's fund of basic knowledge.

It is time, at last, that we took active measures to redress the balance of emphasis on pure and applied science.

The very first of these measures must be to develop a wider understanding of the nature of the scientific enterprise among the citizens of our country. The taxpayer has now succeeded the philanthropist as the principal patron of science. If he is to play his role wisely he must be shown that science is not solely or simply a branch of technology, that mere utility has never provided sufficient motive to inspire the curiosity, the initiative, the imagination, and the persistence that is embodied in all great work. To this point J. Robert Oppenheimer has testified,

> We know how little of the deep new knowledge which has altered the face of the world, which has changed —and increasingly and ever more profoundly must change—man's views of the world, resulted from a quest for practical ends or an interest in exercising the power that knowledge gives. For most of us, in most of those moments when we were most free of corruption, it has been the beauty of the world of nature and the strange and compelling harmony of its order, that has sustained, inspirited, and led us. . . . If the forms in which society provides and exercises its patronage leave these incentives strong and secure, new knowledge will never stop as long as there are men.

This declaration of motive might seem, at first glance, a selfish one– it is as if science should be supported because scientists enjoy it. However, the record shows that the trained human mind set free to choose its own objectives turns invariably to deep and significant enterprises. Warren Weaver expressed it thus:

> The most imaginative and powerful movements in the history of science have arisen not from plan, not from compulsion, but from the spontaneous enthusiasm and curiosity of competent individuals who had the freedom to think about things they considered interesting.

If the public is to find such motives for the support of science, then it, too, must be able to enjoy those fruits of research that are beautiful, significant, and interesting as well as useful. Here, in fact, we enter a much wider area of concern than the annual appropriation for the National Science Foundation. For lack of such participation in the life of science we are witnessing a retreat to authority in many quarters in our culture. Among people who are engaged in science there should be more than a guild member's interest in the fact that the major movements in our arts and letters today are antiscientific in spirit.

There is good reason why our contemporary romantics should turn the wrath of their frustration upon science. In the 400 years since Copernicus the scientific enterprise has brought more than an industrial revolution. It has undermined the ancient absolutes in which men once found the purpose and plan of their existence. Nor has the much-praised utility of science proved an unmixed blessing. Technology has made possible, indeed has necessitated, the organization of superstates, giant cities, and vast industrial enterprises. With the attendant centralization of initiative and authority, the individual becomes the anonymous creature of decisions and compulsions originating he knows not where. It is not hard for 20th century medievalists to show that the serf found more happiness in the security of his bondage than modern man in the insecurity of his liberation.

The demands of the human spirit cannot be denied. If we are to maintain individual freedom in our crowded world and manage civilization democratically,

then each man must have conviction in his own worth as an individual and purpose that fulfills the personal miracle of his existence. It is now too late in the history of science for men to satisfy these demands by retreat to authority. It is, in fact, impossible for the human mind in its integrity to deny for long the inescapable conclusions of its capacity to know and think.

The rational method offers no absolutes and no blueprints prepared in advance to tell us what we want to live for. But science does broaden and secure the ground upon which men can make their choice. It has already shown that human life is not fated to be, in the words of Thomas Hobbes, bloody, brutish, and short. In our increasingly complete and connected knowledge of the cosmos we have an ever clearer understanding of ourselves and our place in nature. We see that the perfected man, that ideal of the 18th century Enlightenment, is the ultimate product of the cosmic process as it is known to modern science.

Science thus bears upon the ends as well as the means of the life of man. We have need for a better understanding of science among the members of our society not only that we may use the power which such understanding gives us, but that we may use it well.

Liberty Hyde Bailey

MANY great men have served on the staff of Cornell University, but it is probable that none contributed so much to the university and to the country as did Liberty Hyde Bailey. Professor in the university from 1888 to 1903 and dean of the College of Agriculture from 1903 to 1913, he retired in 1913 to devote the remainder of his life to taxonomic research in the field of botany. He died 25 December 1954.

Bailey was born on a farm in the wilderness of South Haven, Michigan, in 1858, 3 years after the founding of the first agricultural college in the United States at Lansing, Michigan, and 2 years after Senator Morrill presented to the Congress the land-grant act that bears his name. Both of these events were to play a large role in Bailey's career.

The farm in the wilderness was a world in itself. Soap, candles, leather, cloth, food, and fuel were all produced on the farm. Friendly Indians peered through windows of the home to see what the white man ate and how he lived. Bailey witnessed the transition of the farm from a self-sufficient unit to the highly specialized and mechanized farm of today. During this period he contributed greatly to making the farm a better way of life—and to a better means of living.

As a young boy he began to marvel at the wonders of nature. At the age of 10 he was collecting plants, insects, and rocks and creating museums in his home or in the barn. At the age of 14 he was grafting scions of superior quality to fruit stock of inferior quality for farmers in his neighborhood. With the aid of a neighbor he began a more systematic study of plants. The land, the fields, the streams, the forest, and books were his primary interests. It was natural, therefore, that he should enroll in the Michigan Agricultural College (now Michigan State College). Here he was influenced by one of the masters in botany and soon was collecting plants for the herbarium and for classroom use.

Following graduation Bailey became a newspaper reporter, but after some months in this field he accepted a position as assistant to Asa Gray, the famous botanist of Harvard University. He became professor of horticulture and landscape art at Michigan State College in 1885. Here he established a department of horticulture, the first in the United States. His reputation as a teacher and scholar and his zeal to bring knowledge to the farmer attracted the attention of Cornell. Bailey was then invited to become professor of general and experimental horticulture and began his work at Cornell in 1888.

His impact on the College of Agriculture was enormous, and he was recognized immediately as an inspiring teacher. He stimulated research and extension teaching. Graduate students came to work under his direction, and a host of his students became leaders in the field of horticulture. Textbooks in horticulture, as well as in other fields of agriculture, were lacking. He began to write books on various phases of horticulture, plant breeding, and evolution, and as an editor he stimulated the preparation of textbooks in the various fields of agriculture. These total more than 100.

Bailey's arrival at Cornell catalyzed the extension movement. He traveled widely in the state, he wrote bulletins on the experimental and research work, and when, in 1894, the state of New York appropriated $15,000 for extension work at Cornell, he initiated experiments to control diseases of the grape by the use of bordeaux mixture. This was pioneer work.

Bailey succeeded Isaac Phillip Roberts as dean and director of the College of Agriculture in 1903. The college was lacking in financial support, and the need for a substantial college of agriculture was clear. Roberts, aided by Bailey and others, had prepared the groundwork and had earned the good will of the farmers. Both emphasized the need for a New York State College of Agriculture supported by the state. Despite active opposition by various educational institutions of the state of New York, legislation was enacted in 1904 to establish the New York State Col-

lege of Agriculture at Cornell University. The part played by Bailey in the formulation of a bill and its enactment cannot be overemphasized.

Under Bailey the college grew rapidly. From an enrollment of 100 students in 1902, it grew to 1400 by 1913. The staff increased from 11 to about 100. By 1906 the functions of the college were established by the state as teaching, extension, and research. Bailey believed firmly in the freedom of research. He believed that extension work should reach children and women as well as the farmer. He created a department of home economics, now a large college at Cornell, and fostered nature study for children. Andrew D. White, the first president of Cornell, said in 1914, "When Mr. Roberts came a change began; that was the turning of the tide. Then came the prodigious success of Mr. Bailey."

Bailey's viewpoint on education was broad. In an address made in 1910, he discussed the "Place of agriculture in higher education." He referred to the fact that education in the past had not been related to the living and had been confined to the privileged classes. Then he stated:

> We have practically left the old definition of culture as the end-all and be-all. We are escaping our bonds. We are rising beyond the narrowness and poverty of old educational systems. . . . We shall not lose the old. If the old will no longer constitute the whole it will still contribute its part in the development of the race . . . and be absolutely more important than it has ever been in the past. . . . We really believe that an educated man is not determined by the particular route through which he has come, but by the perfectness to which he has developed in breadth of view, clear reasoning, good judgment, tolerance, high ideals, sensitiveness to art and nature and devotion to service.

Bailey was a prolific writer and was in great demand as a lecturer, not only in the United States, but in many foreign countries. He contributed countless articles to the press and to magazines. He edited and wrote many articles for the *Cyclopedia of American Horticulture*, four volumes; *Cyclopedia of American Agriculture*, four volumes; and *Standard Cyclopedia of Horticulture*, initially six volumes. Of all his publications, he was probably proudest of his book, *The Holy Earth*, which was recently reprinted. His writings ranged from verse to philosophic and social articles and to scientific treatises.

President Theodore Roosevelt, in 1908, appointed Bailey chairman of the Commission on Country Life, the result of which was a broad survey of agriculture in the United States; the report of this survey was written by Bailey.

After his retirement in 1913, Bailey resumed his botanical investigations. He had been interested in the great variability of plants of the genus *Rubus* (blackberries and raspberries), and throughout his career he had collected plants of this genus. He had maintained an extensive herbarium of natural and cultivated plants. Soon after his retirement, he gave Cornell University his herbarium, a valuable collection of botanical books, and the building in which they were housed. This is now known as the Bailey Hortorium and is a part of the College of Agriculture. It is devoted to the origin, evolution, and taxonomy of cultivated plants. Until a few years before his death, Bailey devoted his time to a study of palms, making arduous trips to the tropics for that purpose, and he became the world authority on this important group of plants. In addition, he published memoirs on *Rubus* and on various other genera of plants.

His leadership in the fields of horticulture, agriculture, and botany and his reputation as a philosopher and writer brought him honorary degrees from various universities, medals from horticultural societies of the United States and foreign countries, and membership in learned societies throughout the world. He was a fellow of the American Academy of Arts and Sciences and a member of the National Academy of Sciences and of the American Philosophical Society. He was president of the American Association for the Advancement of Science in 1926 and of the Botanical Society of America in 1928.

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News and Notes

Science News

Primary responsibility for the technical planning and preparation for this country's participation in the United Nations-sponsored **International Conference on the Peaceful Uses of Atomic Energy** has been assigned to the U.S. Atomic Energy Commission. Preliminary plans for U.S. participation in the conference, which is to take place in Geneva, 8–20 Aug. [*Science* **121**, 156 (4 Feb. 1955); **121**, 231 (18 Feb. 1955)] were announced on 23 Feb. At that time the commission named George L. Weil as technical director for U.S. participation. Weil, who wrote the article on "Hazards of nuclear power plants" that appears in this issue, pages 315–317 was formerly director of reactor development for the ACE; at present he is a consultant on atomic energy to the AEC as well as to private firms.

The AEC is assembling, through leading educational institutions, industrial establishments, and research centers, both Government and private, technical information in the fields appropriate to the agenda. The commission also is planning a technical exhibit in which more than 60 institutions and firms already have expressed an interest.

Invitations are being issued requesting that 500-word abstracts of the U.S. papers to be considered for the program be mailed *before 11 Mar.* to: Office for International Conference, U.S. Atomic Energy Commission, Washington 25, D.C. Abstracts of accepted papers must be submitted by the AEC to United Nations Secretary-General Dag Hammarskjold by 15 May; he must receive full texts before 1 July. Interested individuals should communicate with the administrative heads of their organizations for copies of the conference agenda and rules of procedure.

Homi J. Bhabha of India has been named president of the conference. Walter G. Whitman of Massachusetts Institute of Technology, who has been engaged as an officer of the U.N. Secretariat, has been assigned to serve as the meeting's secretary-general. Hammarskjold will appoint six vice presidents from nominees to be designated by Brazil, Canada, France, the U.S.S.R., Great Britain, and the United States. A U.N. internal working party to assist Hammarskjold on conference mattters includes Ralph Bunche, Gunnar Randers, and Ilya Tchernychev.

The conference is an outgrowth of President Eisenhower's atoms-for-peace proposal to the United Nations on 8 Dec. 1953, when he urged that the atomic resources of the world be mobilized to apply the benefits of atomic energy to the cause of peace. The program will include discussion of reactor technology; atomic power; radiation protection; applications of atomic energy to biology, medicine, and agriculture; and the industrial uses of radioisotopes.

Each participating country may be represented by no more than five persons, but these representatives may be accompanied by as many advisers as are necessary to insure adequate presentation and discussion of technical papers. A set of rules has been drafted that is intended to keep political issues out of the discussion.

On 7 Feb. during the hearings being conducted by the Joint Congressional Committee on Atomic Energy on the state of the United States **atomic energy industry,** Walker L. Cisler, president of the Detroit Edison Co., said that prices offered by the Government for atomic materials were "about half" of what he expected them to be and provided no incentive to private industry to construct commercial atomic power plants. He stated that private industry "could not carry out accomplishment of a breeder reactor without government help."

James G. Beckerly, former director of classification for the AEC, observed that existing secrecy rules were hampering the industrial development of atomic energy and have not deterred the "nuclear arming" of Russia.

This testimony indicates why progress in the peacetime development of nuclear energy has not been more rapid, although more than a year has passed since President Eisenhower's statement to the United Nations on this country's desire to facilitate the use of atomic energy for the good of mankind. However, recent events offer some encouragement in this area. On 10 Feb. the Consolidated Edison Co. of New York announced that it is planning to build what will probably be the first atomic power plant in the United States financed entirely by private capital, and on 12 Feb. the AEC made public an agreement to sell the Government of India 10 tons of heavy water, one of the most efficient materials available for moderating nuclear reactions under controlled conditions.

This latter move is particularly timely in the light of a statement by Sen. John W. Bricker (R., Ohio), who headed a Congressional subcommittee that has just completed a 5-wk tour of 11 nations in Europe and the Far East. He said that much of the goodwill won for the United States by the President's UN speech in Dec. 1953 would be lost unless this country came forward immediately with "some concrete and formal way of demonstrating its willingness to get on with atomic cooperation."

Britain has committed herself to a 10-yr program for building **12 nuclear power stations.** In a White Paper introduced in Parliament on 10 Feb., a plan that can be varied as necessary describes an initial capacity of 1.4 to 2 million kilowatts; Britain's present capacity is a little more than 20 million kilowatts. The price, 0.7 ct/kw hr, will be slightly higher than the current cost of coal-generated power; however, since Britain is having to import more and more coal, the price of coal-generated power is expected to rise.

The cost of the new program will be £300 million, or $840 million, but this will be offset by reduction and, perhaps, cessation in the construction of conventional generating stations. In discussing the project, Geoffrey Lloyd, Minister of Fuel and Power, said: "This is a historic day for Britain. I know of no other nation that has yet launched a nuclear power program on this scale."

The **bubble chamber,** a new device that combines the experimental possibilities of the Wilson cloud chamber with the high-mass density available in photographic emulsion techniques, was described at the recent meeting of the American Physical Society in New York. The feasibility of using the bubble formation in a liquid to make the path of ionizing particles visible was first demonstrated by D. A. Glaser of the University of Michigan, and the instrument was further developed by experimentalists at the University of Chicago and at the Radiation Laboratory in Berkeley. At present the device is being used in several laboratories to study high-energy nuclear events.

The bubble chamber makes use of the unstable system of a superheated liquid—that is, liquid hydrogen at a temperature above its boiling point. As soon as ionizing radiation enters the system, gas bubbles are formed and the liquid starts to boil almost immediately. If, however, a picture of the bubble formation is taken a few microseconds after the ionizing event takes place, then the bubbles formed along the path of the ionizing radiation give rise to a visible track.

The high density of the liquid, the almost complete absence of undesired tracks owing to the shortness of the time interval during which the chamber is sensitive to ionizing radiation, and the possibility of taking pictures in rapid sequence make the bubble chamber an extremely versatile instrument for the study of high-energy events.

At a New York Academy of Medicine conference on 10 Feb. [*Science* **121**, 284 (25 Feb. 1955)] Albert Szent-György, director of the Institute for Muscle Research at Woods Hole, reported the isolation of a **flavonoidlike chemical in the thymus,** one of the least understood glands in the body and one that has heretofore been considered rather unimportant. In human beings it is located high in the chest. It continues to develop until the second year of life, remains stationary until about the 14th year, then undergoes a fatty metamorphosis and atrophy.

During his presentation Szent-György exhibited a small vial of the new substance, which he had extracted from more than 15 kg of calf thymus, saying

> This little tube contains 1½ g of an intensely yellow substance which I extracted from animal tissues, from the thymus gland, in which it is present in amazingly high quantity of the order of 0.1 mg/g of fresh tissue and is present in the gland in a colorless form as part of a complex.

He explained that this existence in the gland in colorless form is the reason the material has eluded detection.

Voks, the bulletin of the U.S.S.R. Society for Cultural Relations with Foreign Countries, reports that the U.S.S.R. has established two **weather stations,** North Pole-3 and North Pole-4, **on drifting ice floes** in the central arctic. Describing life on the ice floes, the article states that there are two types of dwellings, prefabricated cottages on skids and tents. The tents "are made of many layers of fabrics stitched together with warm interlinings" and capable of providing warmth even when the temperature outside drops to −40°F. "The stations have helicopters, tractors, and cross-country motorcars at their disposal," as well as "gas heating, electric light, radio, and even telephone communications." Communication with the islands' personnel, "outstanding scientists and experienced polar explorers who have spent more than one winter in the arctic," is maintained by radio and aircraft.

Twelve scientists have accepted assignments to serve on the new **Human Embryology and Development Study Section** announced recently by the Division of Research Grants of the National Institutes of Health, Bethesda, Md. Louis M. Hellman of the State University of New York, New York, N.Y., has been named chairman, and the members are Josef Warkany, Children's Hospital, Cincinnati, Ohio; Warren O. Nelson, University of Iowa; Edith L. Potter, Chicago Lying-In Hospital; Howard C. Taylor, Jr., College of Physicians and Surgeons, New York; Harry H. Gordon, Sinai Hospital, Baltimore; Louis B. Flexner, University of Pennsylvania; Donald H. Barron, Yale University; Louis K. Diamond, Children's Hospital, Boston; Duncan Earl Reid, Boston Lying-In Hospital; Katherine Bain, Children's Bureau, Public Health Service; and William F. Windle, National Institute of Neurological Diseases and Blindness, NIH. Elsa Orent Keiles, Division of Research Grants, NIH, is executive secretary.

This study section will be concerned with human reproduction and early development, a field that has remained largely neglected. During the past few years, however, there has been a progressive awakening of interest in such problems as infertility, pregnancy and labor, congenital malformations, and the newborn, especially the premature.

The spectacular reduction in maternal and infant mortality related to infectious diseases is perhaps the most important factor responsible for this increased interest. Other factors have been the appearance of a number of promising research leads that have established a definite relationship between disease of the pregnant woman and congenital anomalies in the offspring; the recent developments in retrolental fibroplasia; and the growing trend toward appointment of full-time faculties in obstetrics and pediatrics.

The American Council on Education has proposed a **tax credit plan** to aid students in institutions of higher learning as an antidote to the serious manpower shortages that exist in professions and vocations for which a college education is essential. These shortages are defined in a comprehensive study recently completed by Dael Wolfle for the Commission on Human Resources and Advanced Training. His investigations show that of the students in the upper two-fifths of high-school graduating classes—a group of approximately 342,000 per year—only 51 percent enroll in college. There is evidence that of the remaining 49 percent, half are probably prohibited from continuing their education by lack of funds. In addition to reporting in detail on the areas in which the supply of college graduates is insufficient to meet immediate needs, Wolfle notes that as the population increases the demand for professional workers increases at double the rate.

If substantial tax relief were given for student fees paid to tax-exempt public and private educational institutions, parents in the $8,000 to $12,000 a year bracket, who now require partial scholarships to keep their children in college would be able to forego these scholarship funds, thus making them available for those children coming from homes of lesser financial ability. Some institutions, without curtailing the support given to superior students from low-income homes, could conserve some of the operational funds now used for scholarships and make them available for faculty salaries and maintenance of plants, thus improving the quality of instruction.

The plan proposed, which has been studied, in several different forms, by numerous educational groups for more than a year, is based on a formula suggested

by the Resolutions Committee of the Taxation Section of the American Bar Association at its 1954 convention. Briefly, the plan provides that 30 percent of student tuition and fees actually paid by the taxpayer be applied as a tax credit on the amount of income taxes otherwise payable. This means that all taxpayers who pay a given amount of tuition and fees would receive the same tax benefit in dollars, regardless of their income tax bracket.

There is now general agreement among those who have been involved in the study that this tax credit method is much superior to the previously suggested plan of making the cost of tuition and fees deductible from income. The tangible advantage to those in low-income brackets is evident.

The plan that is being proposed is supported in principle by the Association of State Universities, the Association of American Colleges, the American Alumni Council, and other educational groups; and it has been specifically endorsed in detail by three committees of the American Council on Education, which represents the entire range of public and private, low-tuition and high-tuition institutions existent in this country.

Scientists in the News

The Albert Einstein College of Medicine of Yeshiva University has announced the following appointments: department of anatomy, **Ernst Scharrer,** professor and chairman, and **Berta Scharrer,** professor; department of biochemistry, **Abraham White,** professor and chairman; department of medicine, **Irving London,** professor and chairman; department of pathology, **Alfred A. Angrist,** professor and chairman; department of pediatrics, **Henry L. Barnett,** professor and chairman; department of physiology, **Henry D. Lauson,** professor and chairman; department of preventive and environmental medicine, **Marcus D. Kogel,** dean, professor, and chairman, and **Henry B. Makover,** professor; department of pharmacology, **Alfred Gilman,** professor and chairman; department of psychiatry, **Milton Rosenbaum,** professor and chairman, and **John Frosch,** professor and executive officer; department of radiology, **Milton Elkin,** professor and chairman; department of surgery, **Leo M. Davidoff,** professor and chairman, and **Charles B. Ripstein,** professor and executive officer.

Marcus E. Hobbs, chairman of the Duke University department of chemistry since 1951, has been named dean of the Graduate School of Arts and Sciences, a post formerly held by **Charles S. Sydnor,** who died last March. New chairman of the chemistry department is **John H. Saylor,** who previously served as executive officer of the department and director of undergraduate studies.

The 1955 annual Hermann M. Biggs memorial lecture of the New York Academy of Medicine, on the "Medical aspects of alcoholism and drug addiction," was delivered jointly on 3 Feb. by **Giorgio Lolli,** director of the Silkworth Memorial Service, Knickerbocker Hospital, who spoke on alcoholism, and **Harris Isbell,** director of the Addiction Research Center, U.S. Public Health Service Hospital, Lexington, Ky., who dealt with drug addiction.

Thomas H. Ham, blood specialist and professor of medicine and chairman of the Committee on Medical Education at Western Reserve University, has been appointed to the National Advisory Health Council of the Public Health Service, U.S. Department of Health, Education, and Welfare.

F. Peyton Rous, pathologist and member emeritus of the Rockefeller Institute for Medical Research, delivered the annual Jean Redman Oliver lecture at the State University of New York College of Medicine in Brooklyn on 24 Feb. His subject was "Cancer causation as viewed today."

Duncan S. Ballantine has been appointed president of Robert College and the American College for Girls, both of which are divisions of Istanbul American College, Istanbul, Turkey. Ballantine was president of Reed College from 1952 until last fall; previously he was on the faculty of Massachusetts Institute of Technology.

Robert College is the oldest American college abroad, having been founded in 1863. The American College for Girls was opened as a secondary school in 1871. Although they are chartered as separate corporations in the United States, the colleges were united in 1932 under a joint administration to form one institution. Ballantine's appointment is subject to the approval of the Turkish Government.

Ephraim Shorr, professor of internal medicine at Cornell Medical School, New York, and director of the Special Metabolic Service of New York Hospital, will give the annual Meyer Bodansky lecture at the University of Texas Medical Branch, Galveston, on 21 Mar. on the subject of endocrine factors in relation to electrolyte and water balance.

Roy P. Pennington, who was born and educated in Canada, has returned to that country after serving from 1949 to 1955 in the agronomy department at Pennsylvania State University. He has assumed management of the American Potash Institute's Canadian office in Hamilton, Ont., following the retirement of **E. K. Hampson,** Canadian manager since the institute was formed in 1935.

Albert S. Richardson, for 33 yr a research chemist for the Procter and Gamble Co., Cincinnati, has retired. He received his A.B. degree in 1913 and his M.A. degree in 1915 from Princeton University and continued there until 1920 as an instructor in chemistry, with an interlude of 2 yr with the Army Chemical Warfare Service. In 1920 he joined the Du Pont Co. as a research chemist, and in 1921 he moved to Procter and Gamble. He returned to Princeton for several

months in 1927 and received his Ph.D. degree under Hugh S. Taylor. At Procter and Gamble he was largely responsible for the growth and development of the research department. Richardson's work has long been concerned with industrial catalytic hydrogenation and the chemistry and physical chemistry of long-chain organic compounds such as fats, oils, soaps, and synthetic detergents.

His American Chemical Society activities include many years of service on the advisory boards of *Industrial and Engineering Chemistry, Chemical and Engineering News,* and the American Chemical Society News Service. He is a past chairman and trustee of the Cincinnati section, and in 1951 the section chose him to receive the second annual Eminent Chemist award. Richardson has also been active in the affairs of the American Oil Chemists' Society, having served as president in 1931 and as a member of the governing board, the referee board, the editorial advisory board, and the Smalley Foundation Committee.

Joel T. Boone, vice admiral, MC, USN, retired, has resigned as chief medical director of the Veterans Administration. He is succeeded by **William S. Middleton,** a physician who has been associated with VA in a consultive capacity for more than 30 yr.

William C. Hoida, who has been a member of the *Biological Abstracts* staff since March 1954, has been appointed assistant editor by the board of trustees.

William A. Hickey, Capt., USN (Ret.), has been appointed dean of the Engineering College of Detroit Institute of Technology. A naval engineering and administrative officer for 31 yr prior to his retirement early in February, Hickey's most recent post was supervising inspector of naval materiel, Central District, with headquarters in Chicago. He succeeds **Clarence C. Winn,** who has become dean emeritus after holding his office for 31 yr.

Carl S. Marvel, professor of chemistry at the University of Illinois, under whose leadership more than 125 new kinds of synthetic rubber have been compounded, will be honored in Chicago with the gold medal of the American Institute of Chemists, which will be presented during the institute's 32nd annual meeting, 11–13 May. He is being cited for "noteworthy and outstanding service to chemists through his teaching for many years and because of his noteworthy research in the field of organic chemistry."

Jacob Cholak, associate professor of industrial health at the University of Cincinnati, has been named eminent chemist for 1955 by the Cincinnati section of the American Chemical Society.

At the annual meeting of the Academy of Natural Sciences of Philadelphia on 15 Feb., **Charles M. B. Cadwalader** announced his retirement, marking the end of 30 yr of active, official voluntary service to the academy. He had continued on the board of trustees after relinquishing the presidency at the close of 1950. His service began when he answered a request by the board to direct his talents toward increasing membership, and from then until he resigned as president, he devoted all of his time to the institution and, in addition, contributed substantially to its financial support.

In 1928 Cadwalader was elected managing director and in 1937 president, combining the duties of both offices until 1947, when H. Radclyffe Roberts became director. In 1934 Cadwalader received the Philadelphia award, founded by Edward Bok, and contributed the $10,000 accompanying the honor to the academy. He was educated at William Penn Charter, Philadelphia, and St. Paul's School, Concord, N.H. In recognition of his work in the academy, the University of Pennsylvania in 1937 gave him the degree of master of science.

The following appointments to assistant professor have been announced. Baylor University: **William L. Flannery,** microbiology. Loyola University: **Boris E. N. Spiroff,** biological science. Xavier University: **John Tafuri,** biology. Johns Hopkins Medical School: **Gertrude D. Maengwyn-Davies,** ophthalmology. University of Tennessee: **Gene M. Lasater,** neurology and psychiatry.

Meetings

The program for the **Southern Regional Conference on Premedical and Predental Education** that will take place in Birmingham, Ala., 18–19 Mar., includes round-table discussions that are expected to afford an excellent opportunity for medical, dental, and preprofessional educators to question and evaluate the findings and recommendations of the Severinghaus Committee and consider how these can be used to improve the program of preprofessional education in liberal arts colleges. Interested persons are cordially invited to attend. For information write to the sponsor of the meeting, Alpha Epsilon Delta, 7 Brookside Circle, Bronxville, 8, N.Y.

The **Centennial Symposium on General Education,** sponsored by the Basic College of Michigan State College, will take place in the Kellogg Center, East Lansing, 25–27 Apr. National figures in general education, business, law, medicine, and engineering will participate in the meetings, which commemorate the college's 100th year. Among those to be heard on the program are Clarence H. Faust, president of the Fund for the Advancement of Education; Clement L. Henshaw, professor of physics, Colgate University; Paul B. Diederich, member of the research department, Educational Testing Service, Princeton, N.J.; Wilbur S. Howell, editor of the *Quarterly Journal of Speech*; Ralph W. Tyler, director of the Center for Advanced Study in the Behavioral Sciences, Stanford, Calif.; Ernest E. Irons, former president of the American Medical Association and of the Medical Institute, Chicago; Gerald Holton, associate professor of phys-

ics and general education, Harvard University; A. L. Vaughan, assistant dean of the General College, University of Minnesota; Thomas S. Hall, dean of the College of Liberal Arts, Washington University; W. C. Van Deventer, head of the department of biology, Western Michigan College of Education; Clark W. Horton, consultant in educational research, Dartmouth College; and William Hered, examiner in physical science at the University of Chicago and assistant professor of chemistry, Indiana University.

The **Australian and New Zealand Association for the Advancement of Science** will hold its 31st meeting in Melbourne, 17–24 Aug. Visitors from overseas are cordially invited to attend. For information write to the Honorary General Secretary, Science House, 157–161 Gloucester St., Sydney.

The National Science Foundation will provide travel support for a limited number of American Engineers who wish to attend the 6th plenary meeting of the **International Association for Hydraulic Research,** to be held 29 Aug.–2 Sept. at Delft, Netherlands. Application forms may be obtained from the Division of Mathematical, Physical and Engineering Sciences, National Science Foundation, Washington 25, D.C. *Applications must be received by 1 May* in order to be considered.

The 8th annual **Technical Conference on Electrical Techniques in Medicine and Biology** will be held in November. The conference is jointly sponsored by the American Institute of Electrical Engineers, the Institute of Radio Engineers, and the Instrument Society of America. Tentative plans call for holding the conference in Washington, D.C.

The conference serves as a meeting place for physiologists, biologists, cardiologists, radiologists, physicians, physicists, and electronic, electrical and instrument engineers. A large portion of the registration is drawn from the research groups in universities and industries. Authors are invited to submit titles of papers for consideration by the program committee to E. Dale Trout, Conference Chairman, 4855 Electric Ave., Milwaukee 1, Wis.

The **Society of Technical Writers,** a professional organization of men and women in the field of technical publications, is completing arrangements for a national constitutional meeting on 19 Mar. at Hartford, Conn. The membership of the society includes technical writers, editors, and educators employed in various types of industry and in government agencies or, as college faculty members, in the training of technical writers. There are more than 300 members in 23 states, the District of Columbia, and England.

The society was founded in Boston late in 1953 [*Science* **120**, 481 (24 Sept. 1954)] by a group of technical writers and editors engaged in engineering and educational projects who recognized that a professional organization could serve many interests of technical writers. Inquiries concerning membership requirements and formation of chapters have been received by the secretary in recent months from nearly every state and from Hawaii, the Virgin Islands, Canada, England, Netherlands, Switzerland, Venezuela, Italy, Sweden, New Zealand, and India.

The society proposes to establish standards of technical writing, to stimulate the exchange of information of interest in this and allied fields, to encourage competent writers to enter the field, and to encourage the training of technical writers. Committees have begun to work toward these goals. One is considering the desirability of a joint military specification for handbook preparation. Another is preparing a proposal of requirements for technical writing courses on the college level.

The official publication of the society is a quarterly, *Technical Writing Review.* Officers of STW are Paul H. Flint of Tufts College, president; Ronald D. Eames of Raytheon Manufacturing Co., Waltham, Mass., vice president; Ralph W. Fullerton of Kenneth A. Young Associates, Boston, treasurer; and Hyman Kana of National Co., Malden, Mass., secretary.

An **International Symposium on Electromagnetic Wave Theory** sponsored by Commission VI of the International Scientific Radio Union (URSI) and the University of Michigan will be held 20–25 June at the University of Michigan. The work of the symposium will be separated into the following major topics: (i) propagation in doubly refracting media in wave guides (for example, ferrites); (ii) boundary value problems of diffraction and scattering theory; (iii) work in antenna theory of fundamental importance; (iv) forward scattering; (v) multiple scattering of light by colloidal particles.

The program will consist of invited and contributed papers. Those who wish to present papers at the meeting should submit abstracts of not more than 200 words *by 31 Mar.* to K. M. Siegel, Chairman, Symposium on Electromagnetic Wave Theory, Willow Run Research Center, University of Michigan, Ypsilanti, Mich.

Further information on the symposium—registration, housing, program and so forth—may be obtained from J. W. Crispin, Jr., at the same address. Registration and room reservations will be allotted in order of receipt.

The annual meeting of the **Colloquium of College Physicists** will occur at the State University of Iowa, 15–18 June. In addition to a number of invited lectures and reports, the two following items are to be emphasized: special lectures by Bruno Rossi of Massachusetts Institute of Technology on "Recent advances in cosmic ray research," accompanied by research reports from two universities; and the annual exhibit of new devices by members of the colloquium, including a special demonstration in supersonics.

Participating physicists will represent 75 colleges in more than 40 states. Housing will be arranged. For information, write G. W. Stewart, Dept. of Physics, State University of Iowa, Iowa City.

Society Elections

Explorers' Club: pres., Serge A. Korff, New York University; 1st v. pres., William Morden, Chappaqua, N.Y.; 2nd v. pres., A. Robert Leas, Washington, D.C.; 3rd v. pres., Chief of Clan Fhearghuis of Sta-chur, Scotland; sec., Charles Hitchcock, New York, N.Y.; treas., James Allis, Upper Montclair, N.J.

Washington Academy of Sciences: pres., Margaret Pittman, National Institutes of Health, Bethesda, Md.; pres. elect, Ralph E. Gibson, Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md.; sec., Heinz Specht, National Institutes of Health, Bethesda, Md.; treas., Howard S. Rappleye, U.S. Coast and Geodetic Survey (Ret.).

Society of Vertebrate Paleontology: pres., Robert W. Wilson, University of Kansas; sec.-treas., Joseph T. Gregory, Yale University.

Gerontological Society, Inc.: pres., Ollie A. Randall, New York, N.Y.; pres. elect, William B. Kountz, St. Louis, Mo.; sec., N. W. Shock, Baltimore, Md.; treas., J. E. Kirk, St. Louis, Mo.

Torrey Botanical Club: pres., Elva Lawton; 1st v. pres., Ralph H. Wetmore; 2nd v. pres., Edwin T. Moul; corresponding sec., Eleanor R. Witkus; recording sec., Donald P. Rogers; editor, Charles A. Berger; treas., Gily Bard. Representatives to AAAS council are Murray F. Buell, and Lindsay Olive.

Oklahoma Academy of Science: pres., Ralph E. Olson, University of Oklahoma; v. pres., A. M. Stebler, Oklahoma A. & M. College; sec.-treas., D. E. Howell, Oklahoma A. & M. College; asst. sec.-treas., Philip E. Smith, University of Oklahoma; permanent sec., A. C. Weese, University of Oklahoma.

New York Academy of Medicine: pres., Edward J. Donovan; vice presidents, J. Burns Amberson and Robert L. Levy; sec., Frederick H. Wilkie; trustees, Orrin S. Wightman and William F. MacFee.

Education

St. John's University, Brooklyn, has opened its laboratories and lecture halls to industrial scientists, scientific research workers, and laboratory technicians so that they may study on the graduate level in specialized fields of science while still pursuing careers in industry. The program was established with the opening of the spring semester.

Erection of the second major unit of the Medical Sciences Building at the **University of California Medical Center,** San Francisco, will begin this spring. Completion of the $5.6-million unit in 1958 will permit unification of the school's basic science and clinical departments for the first time since the San Francisco fire and earthquake of 1906. At present anatomy, physiology, and physiological chemistry are taught on the Berkeley campus. Space is available for only 76 students in these first-year medical courses; when the classes are transferred to the San Francisco campus, space will be available for a first-year class of 100. First step toward construction of the new unit will be the demolition of the Dental-Pharmacy Building, which was completed in 1898.

A grant of $50,000 from the **General Electric Educational and Charitable Fund** to aid in a fundamental revision of undergraduate electrical engineering education at Massachusetts Institute of Technology has been announced. The grant will aid Gordon S. Brown, head of the department of electrical engineering, in the development of new instructional methods, materials, and techniques based on new concepts of teaching electrical engineering.

A new 5-yr program of study combining work in liberal arts and engineering will be offered at the **University of Delaware** in 1955. It will lead to a B.A. degree in liberal arts and a degree in one of four branches of engineering.

At the end of November **Louisiana State University School of Medicine** held a special ceremony to celebrate the opening of the school's $3.5-million addition. Begun in 1952, the new eight-story medical wing is the first addition to the 24-yr-old school.

In January a ceremony took place for the laying of the foundation stone for the **Agricultural College,** Himayatsagar, near Hyderabad, India.

At the annual meeting of the American Physical Society, Keith R. Symon, formerly with Wayne University and now at the University of Wisconsin, described the design principle of a **new cosmotron** that the Midwestern Universities Research Association hopes to build in the Midwest. Symon conceived the original idea for a fixed-field, alternating-gradient (FFAG) accelerator at a summer-long conference at Wisconsin last year when MURA scientists representing Wisconsin and seven other schools—the universities of Illinois, Iowa, Michigan and Minnesota, Purdue University, Indiana University, and Iowa State College—considered plans for a cooperative research laboratory. Since then they have been working intensively to develop the idea.

The new design is fundamentally simpler, and is expected to present fewer operating difficulties, than present-day cosmotrons. The original designs, however, showed that the new machines would be about 3 times larger than comparable present-day machines, and MURA scientists are now working on ways to reduce the over-all size. The proposed cosmotron would accelerate particles to energies of 20×10^9 to 30×10^9 Mev and would generate many more high-speed particles per unit of time than old-style machines. Existing cosmotrons—and those under construction at the Brookhaven National Laboratory, Long Island, and in Geneva, Switzerland—provide a burst of high-

energy particles every 5 sec. The FFAG accelerator will be able to produce as many as 100 bursts/sec.

Symon's design also makes use of a fixed magnetic field, and no synchronization is necessary; further a simple, direct-current power supply is possible, which obviates the need for the huge flywheel now used. In addition, the fixed field eliminates the complications brought about by eddy currents and remanent fields when the magnetic field strength is varied. The design also permits shimming the iron magnets wherever an imperfection in field has occurred. It is hoped that construction can begin in 1956, although the site and method of financing have yet to be determined. An estimated 5 yr will be required to build the device, and the cost will probably be approximately $25 million.

Available Fellowships and Awards

The Reserve Mining Co. has made funds available to the University of Minnesota for the support of a fellowship in economic **geology and petrography.** The recipient will be expected to work on a Ph.D. thesis problem under the supervision of the Minnesota Geological Survey, a department of the university.

The fellowship is offered on a yearly basis, and reasonable field expenses will be provided by the survey. The recipient must be well trained for research in mineralogy and petrography and have at least the equivalent of the master's degree in graduate work. The stipend for 12 mo beginning 15 June or 1 July will be $3500. The fellowship probably will be renewable for an additional year. Applications for 1955–56 should be filed immediately. For further information write to the Chairman, Dept. of Geology, University of Minnesota, Minneapolis 14.

To combat a shortage of well-trained research workers in the field of veterinary medicine, Lederle Laboratories Division, American Cyanamid Co., has announced the creation of a $1000 **Lederle veterinary medical student research scholarship** for each accredited veterinary college. The scholarships, which become available on 1 July, will be turned over to the dean of each veterinary college for administration and selection of a student. It is hoped that the fund will encourage senior veterinary students to enter research, and that it will stimulate more students to act as assistants to trained research workers, thus relieving the shortage of trained workers.

A 3-yr **scholarship in dermatology and syphilology** has been announced by the New York University Post-Graduate Medical School, a unit of New York University–Bellevue Medical Center. The scholarship, which pays $3000 per year in addition to tuition, is open to graduates of approved medical schools who have completed 1 yr of internship. Recipients will be selected on the basis of academic background and character. Experience in one of the basic sciences is considered desirable but not essential.

Applicants should include a transcript and other pertinent data from the medical school from which they graduated, a letter of recommendation from the dean, and one from the individual responsible for their internship. At least one other letter of recommendation is required. *No applications will be accepted after 31 May* for the class beginning the following 1 Oct. Applications should be sent to the Dean of the Post-Graduate Medical School, 550 First Ave., New York 16.

The Graduate Institute for Applied Mathematics was founded at Indiana University in 1950, and in 1954 it was strengthened and transferred to the graduate school under its present title, the **Graduate Institute for Mathematics and Mechanics.** This unit, which works in close cooperation with the department of mathematics, is concerned with both pre- and postdoctoral study; for postdoctoral students it offers an opportunity to conduct research with a minimum of formal requirements. Research assistantships are available for outstanding graduate students who have completed at least 1 yr of postgraduate study. Inquiries should be addressed to the director of the institute, T. Y. Thomas, Indiana University, Bloomington.

In the Laboratories

The trend toward greater **capital spending by America's chemical industry** was reversed in 1954 for the first time since 1949, according to a survey by G. P. Neidig of White Weld and Co., New York, in the 10 Jan. issue of *Chemical and Engineering News.*

With the announcement of plans for the construction of a new research and administration center in Corning, the **Corning Glass Works** has undertaken the largest single building project in its 103-yr history. The project includes a three-story research laboratory, a one-story building housing laboratory and development shops, and a nine-story office building. Nearly 250,000 ft² of floor space will be added to laboratory and office facilities. The buildings will be ready for occupancy approximately 18 mo after ground is broken.

The new facilities will more than double the present amount of space devoted to research. A year ago the company spent $5,220,558 for research and development, a sum amounting to 3.5 percent of its sales and almost double the rate for all United States industries.

Foster D. Snell, Inc., New York chemical and engineering consultants, have announced the purchase of the **Crippen and Erlich Laboratories, Inc.,** of Baltimore, Md. Raymond C. Crippen founded this laboratory in 1949 after spending several years first as a graduate assistant in chemical engineering at Johns Hopkins University and later as director of research for Penniman and Browne, Inc., of Baltimore. The original laboratory was expanded early in 1954. Under the new ownership Crippen will continue as

secretary-treasurer of the corporation and director of the laboratory, which will operate for the present as a wholly owned subsidiary of Foster D. Snell, Inc. The other officers of the new subsidiary will be Foster Dee Snell, president, and Chester A. Snell, vice president.

The Baltimore subsidiary includes laboratories for analysis, instruments, paint and varnish, fuel and oil testing, and metal analysis and corrosion testing in addition to a small machine shop and pilot plant. The Snell organization works in such fields as insecticides and disinfectants, rubber products and plastics, soap and other detergents, abrasives and polishes as well as market research. Snell also has vitamin and toxicology laboratories at Bainbridge, N.Y., in its Supplee Division.

Frank Adair of the Memorial Cancer Center of New York and former president of the American Cancer Society paid tribute, as guest speaker, to the scientists of the **Waldemar Medical Research Foundation, Inc.,** Norman Molomut, David M. Spain, and L. J. Warshaw, at a recent dinner commemorating the first anniversary of the establishment of their cancer research laboratory in Port Washington, N.Y.

The name of the Atomic Energy Commission's test installation, the Nevada Proving Ground that is 63 mi northwest of Las Vegas, Nev., has been changed to **Nevada Test Site.**

Miscellaneous

The lead article in the March issue of **The Scientific Monthly** is "The oldest tetrapods and their forerunners" by Erik Jarvik. Other articles in this issue include "Sherlock Holmes as an anthropologist," Wilton M. Krogman; "Latent-image formation and chemical sensitization," W. F. Berg; "Identification and guidance of gifted children," Antonia B. Morgan; "New ideas in chemistry," the late John Lennard-Jones; and "The language of science," Charles E. Whitmore.

Among the AAAS activities described are an announcement of the forthcoming International Arid Lands meeting in New Mexico and reports on the recent AAAS Berkeley meeting. Included in this issue are letters from Jay A. Young, Adolf Grünbaum, Richard T. Vineski, Alexander Gode, J. M. Martinez, Jerome Richfield, and Bayard and Evelyn McConnaughey. There are also reviews of 14 books.

The National Foundation for Infantile Paralysis Division of Professional Education, Medical Department, has announced the availability of vol. 8, No. 12 (Dec. 1954) of ***Poliomyelitis Current Literature,*** a periodic annotated list.

In February the Technical Assistance Program of the United Nations Educational, Scientific and Cultural Organization, United Nations, N.Y., announced **science and engineering vacancies** in Brazil, Egypt, India, Indonesia, Israel, Pakistan, Turkey, and Uruguay.

The Committee on the **Albert F. Blakeslee Memorial Fund,** Smith College, Northampton, Mass., has issued an appeal for contributions in the hope that sufficient money can be obtained to endow a lectureship. Checks should be made payable to Smith College, A. F. Blakeslee Fund. Contributions are deductible for income tax purposes.

A comprehensive 35- by 44-in. wall chart showing more than 120 organic **syntheses based on orthonitrochlorobenzene** is available from the organic chemicals division of the Monsanto Chemical Co., St. Louis, Mo.

Vacancies for statisticians exist in the Bureau of the Census, Suitland, Md., 1 mi from Washington, D.C. Appointments are temporary and salaries range from $4205 to $5940 a year. The positions are in connection with the census of manufacturing, mineral industries, and business. A few of the persons selected will be trained to work with a high-speed electronic computer. Applications should be filed directly with the Board of U.S. Civil Service Examiners, Bureau of the Census, Washington, D.C.

The **American Board of Clinical Chemistry** has authorized preparation and distribution of a *Directory of Certified Clinical Chemists.* This directory is now being distributed to the chemists listed therein and to numerous university departments of chemistry and biochemistry. Heads of hospital departments or other laboratories that engage in clinical chemistry can secure a copy by writing to the secretary-treasurer, Dr. O. H. Gaebler, Henry Ford Hospital, Detroit 2, Mich.

A copy of the "Instructions to Applicants for Certification," as approved by the board at its annual meeting in 1954, is also available without cost. Chemists wishing to apply for certification should secure this information at once, for considerable time is required to complete a formal application. Applications to be considered at the next annual meeting of the Board *must be completed before 31 Mar.*

The ***Directory of Commercial and College Testing Laboratories,*** a successor to the *Directory of Commercial and College Laboratories* published in 1947 by the National Bureau of Standards, is now available. Responsibility for its compilation and publication has been transferred from the NBS to the American Society for Testing Materials by agreement between the two organizations.

The directory lists the locations of testing laboratories equipped and prepared to undertake testing on a commercial or fee basis. Information is given concerning 278 commercial testing laboratories and their 151 branches or offices. A list is also presented of the laboratories of 86 colleges that are prepared to do testing under certain conditions. Research and consulting laboratories are not listed unless they also are engaged in testing on a commercial basis. Copies may be purchased for $1 apiece from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Book Reviews

Mathematical Thinking in the Social Sciences. Paul F. Lazarsfeld, Ed. Free Press, Glencoe, Ill., 1954. 444 pp. $10.

This is an era of rapid interplay between theory and method in sociology and social psychology. There is a search for empirical categories that can be utilized within general theoretical schemes, and a decreasingly slavish reliance upon statistical techniques borrowed from other disciplines. Thus, Lazarsfeld has performed a timely service by stimulating and assembling in this volume a variety of challenging, readable papers which apply mathematics to psychological and social questions *per se*.

Much of the book's specific content relates to the study of the individual human being and his attitudes. It includes such long-awaited materials as Lazarsfeld's own conceptual introduction to latent structure analysis and Louis Guttman's announcement of a psychological theory to match his previously published mathematical theory of principal components. T. W. Anderson applies stochastic analysis to the prediction of future attitudes. Jacob Marschak, in a general discussion of probability, deals with subjective probability, a concept that seems to come close to that of attitude. Herbert A. Simon, in a brilliant exposition, compares models of rational behavior, as these have been developed in economics especially, with models that set limits to rationality and incorporate such notions as motivation and learning. Guttman in a second paper introduces, and illustrates from mental testing, a new radex theory of factor analysis. Portions of the book also relate to the study of the group, as distinct from the individual: notably, in Simon's mathematical translation of certain of George Homans' theoretical postulates; Nicolas Rashevsky's enunciation of models for imitation and social status distribution; and James S. Coleman's lucid commentary on the Rashevsky models.

Apart from its specific content, the volume illustrates the general role which may be played by mathematical thinking in the social sciences. First, it provides numerous instances of the use of mathematics to derive additional propositions from initial theoretical postulates—propositions that might not have been reached through the more cumbersome language of words. Second, certain of the models—those involving status, for example—may perhaps seem to be oversimplifications, poor representations of empirical reality. If so, this should point up the challenge of mathematics to the substantive theorist to clarify his concepts to examine his assumptions, and to communicate with greater precision. Third, the book suggests the relative ease of comparing and integrating theories from diverse fields once these theories have been translated into the basic language of mathematics. Marschak, for instance, demonstrates from economics that groups cannot always be effectively treated as mere aggregates of their individual members, a principle that might well be heeded in developing further sociological group models. Finally, the interplay between models and data, the *sine qua non* of useful mathematical application, is dramatized in Guttman's engrossing account of the way he fitted together the many solutions to an equation and the several components of an attitude.

The volume represents, of course, an early stage of development. Much research remains to be done before the proximity between many of these models and their empirical counterparts can be determined. Many computational problems must be solved before some of the necessary operations can be performed by the average social scientist. Yet the book points in a direction that should at once quiet the pangs of some who have bemoaned the "emptiness" of earlier quantitative approaches and focus the efforts of others who have long been looking to mathematics for greater precision of conceptualization and measurement and fresh insights into the complex relationships among the variables of social science.

MATILDA WHITE RILEY
Department of Sociology, Rutgers University

Active Networks. Vincent C. Rideout. Prentice-Hall, New York, 1954. xvi + 485 pp. Illus. $10.65.

Most physical objects are passive in the sense used in the expression "passive networks." These are electric circuits consisting of resistances, capacitances, and inductances, containing no energy sources, and characterized by having a small "response" to a small "stimulus" (except for relatively rare unstable configurations), and in which transient disturbances ultimately die out. If a component capable of amplification—for instance, a vacuum tube and associated power supply—is added to such a network, transients need not die out; large response (output) can be obtained with a small stimulus (signal); the network is "active." Many active physical systems can be devised—electric, mechanical, chemical, their combinations, and others. The great variety of behavior possible in such systems and their comparative "irritability" make them, rather than passive systems, what one would choose in constructing physical analogies for vital behavior.

The tube circuits of the communication and controls engineer seem to be the portion of this field that has been most highly developed. This book gives an excellent introduction to a large variety of electronic circuits, makes no demands on the reader's mathematical knowledge beyond the elements of differential and integral calculus, is well organized, and is well written. Each of its 15 chapters has a bibliography of textbooks and original journal articles, several hundred carefully chosen references in all, help-

ing the reader to find more detailed treatments of the scores of topics necessarily presented very briefly. Approximately 150 exercises, many with several parts, present the student with practical problems of circuit design and well illustrate the principles discussed. Graphic as well as analytic methods are analyzed in detail. The hundreds of clearly drawn line diagrams of circuits, curves, wave-forms, and so forth add materially to the vigor and clarity of the presentation.

After an introductory chapter on fundamental concepts, including those of elementary network analysis, a discussion is given of the characteristics of vacuum tubes, gas tubes, transistors, and magnetic amplifiers as elements of active networks. The next six chapters give a comprehensive treatment of low-pass and band-pass amplifiers, transient response, negative feedback amplifiers, special types of small signal amplifiers, and power amplifiers. A chapter on oscillators is followed by three on modulation and frequency conversion, frequency, phase and pulse modulation, and detectors and demodulators. The last three chapters discuss wave-shaping circuits, relaxation oscillators and trigger circuits, and noise and information theory. There are three appendixes on Fourier analysis, Laplace transforms, and tube and transistor characteristics. Relay circuits, amplidynes, and the like are not discussed at all, although positioning servosystems are briefly discussed. The book is highly recommended as a course textbook or for self-study and deserves great popularity. If this book is typical of what the author can do, and the uniformly high level indicates that it is, it is greatly to be hoped that further books will be forthcoming from his pen.

JEROME ROTHSTEIN
Signal Corps Engineering Laboratories

Cellulose and Cellulose Derivatives. pt. I. Emil Ott, Harold M. Spurlin and Mildred W. Grafflin, Eds. Interscience, New York–London, ed. 2. 1954. xvi + 509 pp. Illus. $12.

This is the first of three volumes designed to replace and modernize a much larger single-volume treatise which appeared about 12 years ago. The practical advantage of easier handling will be welcomed by those who use the book frequently. All three volumes of the new edition will be necessary ultimately for easy use, since indexes are to be located only in the third volume.

This volume comprises five main chapters, each sectionalized according to a pattern that had been set up in the original edition. In general, the same authors have participated, although new authorship now includes McBurney, Howsmon, and Lewis.

The chapters for the most part have been completely rewritten. The approach differs from that of the 1943 edition, with more emphasis on the objective and critical, rather than the historical, viewpoint and with consequent improvement. This must now be considered definitely a reference work rather than a textbook for undergraduates.

As is stated in the introductory chapter, principal emphasis is on the chemistry of cellulose and its derivatives. There is deliberate omission of many aspects of cellulose technology, such as those that pertain more specifically to industry.

The section dealing with crystalline and accessible cellulose has undergone major changes, which is not surprising in view of the great amount of experimental work done in this field in the last decade. Considerable emphasis is placed on new methods for measuring and controlling orientation of cellulose structure and on its influence on the important physical properties of the cellulose in question. All this invites and stimulates further effort toward a better understanding.

The discussion of the significance of "alpha cellulose" is timely and, although not conclusive, adds greatly to earlier speculations on the same subject.

Degradation of cellulose is comprehensively reviewed, and new attempts are made to correlate such breakdown by various methods with the resulting changes in physical, as well as chemical, properties. The present-day importance of cellulose plastics and cellulose base textiles adds further importance to this critical approach.

A major revision was found necessary in the field of chemical structure of cellulose where the weak-link theory was thoroughly discredited.

This first volume of the revised edition is excellently assembled, authoritative, and well written and if, as is to be expected, the following volumes are equally well prepared, they will become an important addition to both private and public libraries that specialize in advances that have been made in fundamental and applied science.

GEORGE A. RICHTER
Wood Cellulose Development Division,
Eastman Kodak Company

Chemical Specificity in Biological Interactions. Harvard Memoirs, No. 3. Frank R. N. Gurd, Ed. Academic Press, New York, 1954. 234 pp. Illus. $6.

These memoirs are the permanent record of the third of a series of symposiums at the laboratory of the late Edwin J. Cohn and the last he attended. The chapters, with one exception, were derived from the seminars but were written by the speakers afterward in order to permit each to include any ideas suggested by the others during discussion or in summaries that were prepared and distributed.

In the introductory chapter, Cohn emphasizes conclusions that "metals react reversibly with a great variety of proteins in very specific ways." He relates this to the processing of proteins and points out the necessity of avoiding oxidation and changes of pH in isolating tissue constituents. A translation of a specially prepared article by Gerold Schwarzenbach, on the "Specificity of metal complex formation," makes the results of his studies available for the first time in English. Charles D. Coryell discusses "Special prob-

lems in the formation of metal complexes," including a section concerning complex formation of hemoglobin and ferrihemoglobin. In other approaches to the broad problem, George Scatchard, Walter L. Huges, Jr., Frank R. N. Gurd, and Phillip E. Wilcot present "The interaction of proteins with small molecules and ions," and Jack Schubert discusses "The interactions of metals with small molecules." In this latter chapter an interesting section concerns "Metal chelates in relation to drug action." Richard B. Turner directs attention to "Physical and chemical properties of the steroids related to protein binding." Thomas F. Gallagher in "Biochemical problems of the steroid hormones" points out, with some possible answers, the question of why large amounts of a hormone are often necessary to produce an effect, even though great rapidity of disposal leaves only a small amount in the tissues. Shields Warren notes that "The effects of x-ray and other radiation on proteins and living tissues" may be attributed to the hitting of some sensitive volume of the cells.

In chapters that record progress of work, in each instance later carried much further, Vincent du Vigneaud describes the purification and analysis of oxytocin and vasopressin, and Waldo E. Cohn discusses the application of ion-exchange chromatography to the isolation of *a* and *b* nucleotides and further studies on the structure of nucleic acids.

This book, in a fascinating way, shows how contemporary hypotheses and techniques are being applied to the study of the nature, until recently very obscure, of the chemical forces involved in the long-known specificity of biological interactions.

RALPH C. CORLEY
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Organic Peroxides. Their chemistry, decomposition, and role in polymerization. Arthur V. Tobolsky and Robert B. Mesrobian. Interscience, New York–London, 1954. x + 197 pp. $5.75.

The appearance of this book, which was inspired by the desire to elucidate the interesting role of organic peroxides in catalyzing chain reactions such as observed in vinyl polymerizations, dealing as it does with one phase of this broad subject, is convincing evidence of the widespread interest that has developed in high-polymer science in recent years. The excellent review of the chemistry and decomposition of these materials should be of equal interest to many readers. One welcomes this work by these well-known authors, since it serves to draw together many scattered treatments of this subject and to regiment the data into an orderly pattern.

The authors elected to treat their subject under three major headings. The first section deals with the preparation, properties, and structural classification of organic peroxides, which include the hydroperoxides, dialkyl and diaralkyl peroxides, peroxy acids, peroxy esters, diacyl and diaroyl peroxides, and the peroxy derivatives of aldehydes and ketones. The authors have drawn quite freely upon published information in preparing this section and do not attempt to treat the subject in a comprehensive manner in terms of complex organic chemical reactions. In the preface they indicate that this was their intention. Much of the information would have to be augmented by study of the original papers to be useful in the preparation of some of these materials.

The second portion dealing with the physical chemical aspects of the cleavage of the peroxide molecule is discussed as thoroughly as knowledge of the subject will permit. Because the general chemical reactivity between members of this family of compounds is so similar, certain parts of this review seemed repetitious. The mechanism for the decomposition of peroxides by amines proposed by L. Horner and E. Schlink was taken from their early work published in 1949 and does not completely reflect their recent views on the subject, which they published 2 years later. Aside from this, the literature on this phase of the subject seems to have been well covered.

The third section, dealing with the initiation of vinyl polymerization by peroxide decomposition, is treated in a thorough, quantitative manner. Since Tobolsky has been very active in the study of polymerization kinetics, a large portion of this material is taken directly from his work. It could not have been written by a person with a more appropriate background, and it reflects his sincere interest in this field.

The value of this book is greatly enhanced by an appendix of 28 pages in which data are presented on the physical constants of selected organic peroxides, the explosive nature of peroxides, some commercially available organic peroxides, and catalyst efficiency. Several errors in chemical structure appear throughout, but I was well pleased with the format and the adequate author and subject index.

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Rohm & Haas Company

Biochemistry of Cancer. Jesse P. Greenstein. Academic Press, New York, ed. 2, 1954. xiii + 653 pp. Illus. $12.

This book by Jesse Greenstein of the National Cancer Institute is far more than a second edition of a routine textbook. It is a critically prepared, carefully written, and precisely documented presentation of the reliable facts concerning an important and complex topic. Too frequently books of this type become routinized compilations without order of the facts accumulated since a previous edition, but whether perused by a worker in the field or one seeking basic information, this one can scarcely be laid down. The language is clear and simple. The material is conclusive and orderly. The conclusions are cautious and reliable.

It is pleasant indeed to be able to recommend the book to anyone actually or potentially concerned with the problem to which it is addressed. To Greenstein and his many collaborators, great credit is due.

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New Books

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March

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Technical Papers

Respiratory Studies on Mate-Killers and Sensitives of *Paramecium aurelia*, Variety 8

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When stocks 130, 131, and 138 are mated to the other stocks of variety 8, *Paramecium aurelia*, the exconjugants descended from the other stocks die, but the members of the conjugating pairs descended from these three stocks survive and produce normal progeny. These three stocks are called mate-killers; the others are called sensitives. Mate-killers are distinguished from sensitives by possessing visible Feulgen-positive cytoplasmic particles. These particles, called *mu* particles, seem to depend for their maintenance and reproduction, though not for their origin, on a nuclear gene *M*. Mate-killing is thus under the control of both nuclear and cytoplasmic factors (*1–3*).

The genetics of mate-killers appears to parallel the genetics of killers in variety 4 (*4*). In that case, too, the trait is controlled by the cooperative action of a nuclear gene *K* and visible cytoplasmic Feulgen-positive particles, *kappa*. However, the conditions for killing are different. The killing action of mate-killers depends on prolonged and intimate physical contact of paramecia, and so far this killing action has not been produced by fluids in which the mate-killers have lived. With killers, such fluids are active in killing because of the liberation of a poison, paramecin, by the killers, but contact during mating does not result in death.

Simonsen and Van Wagtendonk (*5*), using the Cartesian diver technique, made a respiratory comparison of kappa-killers and sensitives in variety 4. They found that stock 51 killers respire at a rate 150 to 180 percent above that of sensitive animals of identical genic constitution. This fact, together with the lack of respiratory inhibition of killers by sodium azide in concentrations that inhibit the respiration of sensitives, as well as the low cytochrome oxidase activity of killers, led these authors to conclude that an oxidative pathway different from the normal cytochrome system operates in the respiratory metabolism of killer paramecia.

A respiratory comparison of stock 138 mate-killers and sensitives of mating type XVI was undertaken to see whether mu particles alter the metabolism of mate-killers in a manner similar to that found for kappa particles. The sensitives used in these experiments (*6*) were derived from the mate-killers and are isogenic with them. Following prolonged rapid growth at high temperature, mate-killers may lose mu particles and be transformed into sensitives without any associated genic change (*2, 3*). The only difference between the two cultures, then, is the presence of mu particles in one strain and their absence in the other.

The paramecia cultures were grown in flasks on a Ceraphyl infusion inoculated with *Aerobacter aerogenes*, according to the methods of Sonneborn (*7*). Their effective average growth rate was less than one fission per day. In preparation for examination, cultures that had last been fed 2 days earlier were harvested in a Berkefeld filter, were further concentrated by low-speed centrifugation, and were washed several times in exhausted autoclaved culture fluid or in an inorganic salt solution (*5*), depending on which was used as the respiring medium. These concentrated cultures were allowed to stand for approximately 2 hr in either of the two mediums, were washed again, and were then ready for determination of oxygen uptake. This procedure removed the bacteria as a contributing factor in the respiratory studies.

Oxygen consumption was measured with the Warburg respirometer. The number of animals examined per vessel in different experiments varied from 30,000 to 150,000 in a total volume of 3.3 ml. Total respiration varied directly with the number of animals examined. Population counts were made according to Sonneborn (*7*). All determinations were carried out in duplicate.

The data in Table 1 indicate that mate-killers and sensitives respire at about the same rate. Similar results were obtained in the two respiring mediums. Not only do mate-killers fail to differ significantly from sensitives in oxygen consumption, but preliminary experiments indicate that the cytochrome system operates similarly in both, since the oxygen consumption of mate-killers and sensitives was equally inhibited in the presence of 0.001*M* KCN.

If the Warburg technique may be compared with the Cartesian diver technique, these findings are in sharp contrast with those reported for killers. Mu and kappa particles do not seem to impose the same metabolic demands on paramecia. It is, however, possible that mu particles may alter some other metabolic system.

A possible morphological basis for the metabolic

Table 1. Rates of oxygen consumption of mate-killers and sensitives of stock 138, mating type XVI, variety 8. The Q_{O_2} is expressed in millimicroliters per animal per hour.

Respiring medium	No. of experiments	Mate-killer Q_{O_2} mean ± S.E.	Sensitive Q_{O_2} mean ± S.E.
Exhausted culture fluid	11	0.280 ± 0.027	0.260 ± 0.020
Inorganic salt solution	3	.305 ± 0.051	.266 ± 0.058

differences between killers and mate-killers is suggested by a recent demonstration by Preer *et al.* (*8*) that showed that a small proportion of the kappa particles in killers contains one or more refractile areas. These kappas are called "brights," and they are the bearers of paramecin activity. Brights are found only in animals that can produce paramecin, never in those unable to produce this toxin. Bright particles have never been found among the mu particles of mate-killers (*8*). The increased metabolic activity of killers may be a direct consequence of the production of paramecin, and the site of this altered metabolic activity may rest in the bright kappa particles or in their influence on the metabolism of the whole cell.

In this connection, it would be of interest to examine the respiratory activity of paramecia carrying a third type of particle that is neither involved in a toxic effect nor produces paramecin. This particle, called *pi*, was first discovered by Hanson (*9*) in animals that had once been killers and are in all probability mutants of kappa particles. If the higher oxygen consumption of killer animals is indeed a consequence of paramecin production and is correlated with the presence of brights, paramecia containing pi should respire at the same rate as isogenic paramecia devoid of these particles.

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12 November 1954.

Thermistor Electronic Thermometer

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Electronics is receiving increasing attention and finding many applications in the tools of medical research. One of our problems in instrumentation led to a solution that should find application wherever research using small animals is in progress. A research worker in physiology needed to take a record of the rectal, subcutaneous, and skin-surface temperature of experimental groups of six mice each and to observe the variation in these several temperatures over a period of time.

The temperature-measuring units need (i) to remain *in situ*; (ii) to be able to be calibrated to give comparable readings; (iii) to be fairly quick reading; (iv) to be sensitive enough to measure to 1 per cent; (v) to be small enough physically so that an animal as small as a mouse does not experience insuperable discomfort; (vi) to be well insulated, both electrically and against moisture, and to give reproducible results.

We tried both thermocouples and thermistors and settled for the latter as being best suited to our requirements, using the W. E. No. 14B thermistor in a bridge circuit. The voltage divider can be adjusted to give the same voltage across the bridge over the life of the battery. This voltage is checked by the same vacuum-tube voltmeter that serves as the temperature indicator by substituting a voltage divider in place of the thermistor bridge (Fig. 1).

The 19 thermistor bridges (one for measuring the ambient temperature plus six sets of three for the six animals being tested) are identical (Fig. 2), each with a balancing control for setting the minimum temperature reading (in our case, 0°C) and a maximum setting control (in our case, 50°C).

This gives a 2-point adjustment of comparability between bridges. We have found this degree of comparability satisfactory, since the several thermistors that we are using track within the limits of experimental error.

These 19 bridges and the voltage-check divider are connected to the switch points of a three-bank 20-position rotary switch, making it possible to select and measure any temperature by a turn of the dial.

It is necessary to match the sensitivity of the

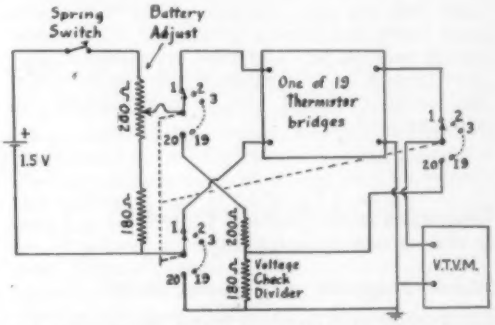

Fig. 1. Thermistor thermometer. Block diagram with supply and check-voltage source.

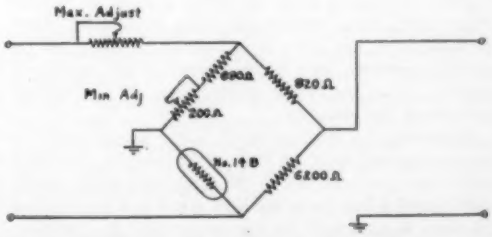

Fig. 2. Thermistor bridge. Nineteen bridges are required in the complete instrument.

V.T.V.M. to that of the thermistor bridge. The lowest temperature is set on the zero of the scale by balancing the bridge, but the highest temperature is set at the full scale reading by adjusting the sensitivity of the V.T.V.M. The maximum setting control of the bridge serves to make the several bridges compare, but serves only as a fine control in matching the bridge to the V.T.V.M.

Calibration. (i) With the 20-point switch in the voltage-check position but with the battery voltage not applied, adjust the balance control of the V.T.V.M. so that the meter reads zero. (ii) With the 20-point switch in the check position and with the battery voltage applied, adjust the battery-adjust control to provide a predetermined reading on the V.T.V.M. This adjustment is important as a means of assuring reproducibility with changes in the age of the battery. The particular reading of the V.T.V.M. is not important as long as it allows adjustment when the battery ages, and providing the maximum adjust on the thermistor bridge can actually adjust for the maximum temperature desired. (iii) With the thermistors in a bath at the lower temperature limit, switch each of the thermistor bridges into the circuit in turn and adjust the minimum control of that bridge so that the meter reads zero. The bridge is now balanced. This adjustment is not disturbed by changes in the maximum control. (iv) With the thermistors in a bath at the upper temperature limit, switch each of the thermistor bridges in turn into the circuit and adjust the maximum control of that bridge so that the meter reads full scale. The scale of this thermometer is not linear, and either a special scale on the meter must be provided or a conversion graph must be prepared between the temperature and the meter reading. The instrument should now be in adjustment and ready for use.

15 November 1954.

Prolongation of Molting Period in the Canary by Long Days

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The stimulating effect on avian gonads of lengthening daily light periods has been studied by many investigators, but little is known about its effect on molting periods. This paper describes the results of studies (*1*) of the effects of long days on the molting periods of the canary.

Beginning on 10 Sept. 1953, eight female canaries were subjected to 20-hr daily light periods. Artificial light was produced by a 100-w electric bulb, which was placed 1.5 m from the bird cages and was turned on from 4 A.M. until 12 P.M. every day. In addition, the birds received natural sunlight in daytime. Eight other female birds exposed to natural daily light periods served as controls. Four birds were kept in a cage. The structure of the cage used for the experiment has been described elsewhere (*2*).

Fig. 1. Curves showing numbers of feathers cast off every 4 days by eight experimental canaries exposed to 20-hr daily light periods (solid line) and by eight control birds exposed to natural daily light periods (broken line).

All the birds were allowed to take water and food *ad libitum*. In order to examine the molting process of the birds, the feathers cast off on the floor of the cages were counted every 4 days, and at intervals the body and wing feathers that were being renewed were carefully observed in each bird.

The results of our experiment are summarized in Fig. 1. The molting of experimental birds was inhibited for about the first 20 days of the experiment. It has already been reported that the pituitary body and thyroid gland are concerned in the inhibition of molting following lengthening of the daily light periods (*3*). The molting became severe again toward December. During January and February 1954 the rate of refeathering was slowed. From March on, the loss of feathers was increased until the beginning of July; after this, a decrease again occurred. However, the birds continued to molt until 9 Nov., when the observation was stopped.

During the experimental period these birds were refractory to the stimulus of long days and did not show any sign of ovarian development. The cloacal region did not swell, and fat was not deposited subdermally. We had already observed that, in the canary, the cloacal region swells and the subdermal fat increases remarkably during the beginning of ovarian development (*4*). This refractoriness of the ovaries to long days observed in the experimental birds is in accordance with observations made by several investigators (*5*).

In control birds, the molting period was terminated

at the beginning of November 1953, indications of ovarian development were observed in May 1954, and molting began at the end of July. Previously we reported that the development of gonads is a prerequisite to the inception of annual molting in the canary (*2, 4*).

In the present experiment, the molting of the experimental birds was in progress during January and February, and it became severe in March, although the ovaries had not developed in the birds. Therefore, it seems highly probable that the molting which occurred in 1954 was not a regular annual molting, which should always occur after the gonadal development, but a continuation of the molting of the preceding year. Thus, long days prolong the molting period of the bird. The reason why the rate of molting was slowed during January and February is not clear, but the observation (*2*) that, in the canary, it requires more thyroxin to induce the molt in winter than in summer, may partly account for the fact.

Burger (*6*), Miller (*7*), and Wolfson (*8*) have reported that long days prolong the refractory period of avian gonads to light stimuli. It has been suggested elsewhere that physiological conditions, especially in the pituitary body, accompanied by the continuation of molting period induced by long days, may be responsible for the prolongation of the refractory period in avian gonads (*4*).

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15 November 1954.

Preliminary Report on the Effect of Ultrasonic Waves on the Crystallization of Honey

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Despite the common belief to the contrary, honey is a perishable product. The yearly loss of honey in a 2-yr storage experiment (*1*) averaged 13 percent. Crystallization is the first step in honey deterioration, which may be followed by fermentation. Honey consists mainly of a mixture of three sugars: levulose 40.5 percent, dextrose 34.0 percent, and sucrose 1.9 percent, all dissolved in water, the amount of which averages 17.7 percent. Honey also contains some other substances, such as dextrines, gums, organic acids, proteins, coloring substances, aldehydes, esters, superior alcohols, rare sugars, and enzymes.

Dextrose, the most easily crystallizable of the three sugars, is the first to form crystals when crystallization occurs. Since dextrose hydrate crystals contain only 9.09 percent of water, when partial crystallization occurs the remaining liquid honey is diluted, and thus offers a better medium for the growth of the osmophilic yeast that is always present in honey (*2*).

Water at ordinary temperatures can dissolve about its own weight in dextrose. Figures are not available to show the extent to which saturation of dextrose is affected by the presence of levulose and other substances except that at 30°C a solution of levulose and dextrose is saturated in respect to dextrose when each of these sugars is present in the solution to the amount of 34.85 percent (*3*). It appears from this that honey is more or less a supersaturated solution of dextrose. But it is also possible that other substances, probably dextrines and proteins, play some role in the dextrose saturation since there are special types of honey, such as the "Tupelo" type, that never or very seldom crystallize. The size of the crystals is considered very important. Large crystals seriously affect the quality (taste and aroma), whereas very small crystals seem to have a rather beneficial effect on the quality.

Assuming that the crystal growth in honey follows the Noyes-Nernst formula (*4*),

$$\dot{V} = \frac{\Delta}{l} S(C - L),$$

where $\dot{V}$ is the rate of crystal growth, Δ in the diffusion coefficient, l is the length of the diffusion path, S is the surface area of the disperse phase, C is the concentration of the solution, L is the solubility of the disperse phase of a given size, and $C - L$ is the absolute supersaturation, we can see from the formula that the easiest way to retard the process of crystal growth is by changing S, which depends on the number of primary nuclei in honey. These nuclei can be small dextrose crystals, colloidal particles, mesotropic crystals of beeswax, or even minute air bubbles occlused during centrifugation. The prevailing practice of heating honey to retard crystallization by more or less eliminating the existing primary nuclei seems to be well founded in this respect. However, the heating is not a practical operation since honey has a high viscosity. There also are other serious disadvantages, the most important of which is the great acceleration brought on by the heat to the browning (Maillard reaction), the thermal coefficient of which is very high ($Q_{10} = 5.4$) (*5*). Heating must be discarded as a treatment for crystallization because it impairs the flavor and aroma, and later leads to the formation of large objectionable crystals.

In view of the fact that ultrasonic waves have been used to degas liquids to destroy microorganisms and for other purposes (*6*), we thought that they might be used to prevent crystallization in honey. A pre-

liminary experiment was readily undertaken with honey samples provided by Everett Oertel (*7*) of the U.S. Department of Agriculture, using a magnetostriction oscillator, made available by V. Williams, tuned to 9 kcy/sec. The treatment lasted 30 min. The samples were examined microscopically immediately after the treatment, and also after storage periods of 1 and 4 wk at various temperatures from +39°C to −40°C, in order to observe the effect of storage temperatures on crystallization phenomena in general. The results were astonishingly successful in every respect. Although we found crystals of different sizes and numbers depending on the storage temperature, in the control samples, not one of the treated and stored samples showed any.

These results are not only important from the practical standpoint of preserving honey, but they also have theoretical significance in view of the fact that treatment with ultrasonic waves has hitherto been supposed to promote crystallization in general (*8*). Furthermore, the treated honey was limpid and had a slightly tart taste that made it superior to the controls that were opaque and generally less attractive. The *p*H of the treated samples was a little lower than the *p*H 3.9 of the controls, but the total acidity was 2.4 mg of NaOH per milliliter of honey in the treated samples and 3.0 mg in the controls. The redox potential was 406 mv in the treated samples and 346 mv in the controls.

Since yeasts are implicated in the spoilage of honey, we thought it advisable to make exploratory tests on the effects of ultrasonic waves on these microorganisms simultaneously with our tests of their effects on the crystallization.

A portion of untreated honey was plated out on acidified potato dextrose agar, and many yeast cells were detected. A portion of the same honey following treatment was similarly plated out, but no yeasts were detected. Microscopic examinations of the treated honey, however, disclosed some isolated yeast cells but very few in comparison with the number found in the untreated portion of the sample, which had a large number of actively budding cells. These results of the effect of ultrasonic waves on the microorganisms in general did not surprise us in view of the extensive literature on the subject (*9*). In order to obtain quantitative data, a more extensive experiment is being undertaken to study in more detail the specific effect of ultrasonics on these microorganisms.

Because the changes brought about in the honey by the ultrasonic waves cannot be attributed only to their mechanical action but possibly also to some chemical effect, probably on the sugar polymers present there and to other oxidation-reduction changes (*10*), a further study of these aspects of the problem is being carried out.

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Recorded Calls of Herring Gulls (*Larus argentatus*) as Repellents and Attractants

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Herring gulls and other sea birds may become pests by feeding on crops (*1*), on fish waste destined for chemical conversion, or by resting on airstrips (*2–4*) where they endanger airplanes. None of the attempts to rid these areas of the birds (*2, 4, 5*) has been entirely satisfactory.

The failure of mere noise to repel these birds (*2, 4, 5*) is probably owing to its lack of biological significance. It seems better to use sounds that have meaning to the species one wishes to repel. Starlings (*Sturnus vulgaris*), for instance, can be repelled from roosts by broadcasting to them the recorded distress call of one of their fellows, and the clearance thus achieved has some permanence (*6*).

Unfortunately, herring gulls do not have a distress call—that is, a call given by an individual when restrained or maltreated. Captive gulls are generally silent; even when buffeted they emit only vague grunts. Gulls, however, have an alarm call which they give when they see a captive gull or detect danger. This call causes other gulls that hear it to leave the region, not precipitously, as in the case of starlings, but by slowly circling away after initially drawing near.

The alarm call usually consists of two parts. The first is a set of two piercing cries in a descending sequence. This alone seems to be an attention call. There follows the alarm call proper, usually of three sharp cries. This has been variously represented in print by earlier workers (*7*) and sounds to us like "cut-cut-cut," with accent on the first note. It may have two, four, or five notes instead of three.

This call, as given by gulls free in the air, was recorded with a tape recorder (*8*). The usual recording consisted of the attention call with two sequences of the alarm call. This unit of about 5-sec duration was

used to produce recordings of any desired length by repeating all or part, separated by intervals of 5 to 10 sec of silence. These recordings were broadcast to gulls with a repeating tape player (*9*) through an ordinary amplifier and loudspeakers.

The immediate reaction of groups of gulls to the sound is striking. At the attention call they rise into the air; they approach the speakers when the alarm notes sound. After this they slowly circle away and leave. The broadcast of only 1 or 2 unit calls will produce this reaction; the gulls continue to fly away even after the call is ended.

This call was tested for immediate repellent effect against gulls feeding on 3 dumps (16 trials), at a sardine cannery (2 trials), on the seashore at 5 different places (7 trials), and at a fish-meal factory (2 trials). At an intensity of approximately 95 db at a distance of 1 m from the speakers, the call was effective in lifting all gulls within a radius of at least ½ mi. At distances of about 100 ft, lower intensities drove all gulls from food. The gulls remained away, after one sequence, for 15 to 90 min, but mostly 30 to 45 min, equalling the repellency obtained by displaying a captive gull for a few minutes.

The most extensive tests (*10*) were made at a dump near Salisbury Cove, Me., where the gulls had fed regularly for many years. At the time of the tests, about 300 gulls were present at all times. The alarm call was broadcast to the gulls in a 1-min sequence consisting of five repetitions of the unit call separated from each other by about 7 sec of silence. This was sounded only when the birds tried to return to the feeding area. The gulls were driven from the dump at 8:45 A.M. EST 9 Aug. 1954, and were denied return until nightfall, 6:45 P.M., the next day. The total potential feeding time during the two days, since the gulls do not feed at night, was 25 hr. The call was broadcast 29 times during that interval. The longest time of clearance was 3 hr, 27 min, the shortest 10 min. For the most part the gulls did not try to return to the feeding area until 30 to 45 min after each treatment. On the afternoon of the second day, the times of individual treatments were reduced to 10 to 20 sec. These worked just as well. Other tests, of 3- to 4-hr duration, at a sardine cannery in McKinley, Me., and a fish-meal processing plant at Eastport, Me., gave similar results.

This call is effective for other gulls. Great black-backed gulls (*Larus marinus*) in Maine and laughing gulls (*Larus atricilla*) on a dump at Atlantic City, N. J., were also repelled. This cross-reactivity is probably the result of the fact that these species often feed together and have similar calls. The alarm call of great black-backed gulls, for instance, is like that of herring gulls, except that it is pitched about one octave lower.

During these tests, a study was made of the food-finding behavior of herring gulls, and a food-finding call was noted. When recorded and played to gulls this proved to be highly attractive. With this call, 20 to 30 gulls could be drawn within a few minutes. These were driven away equally rapidly with the alarm call at the same intensity. The alarm call, therefore, does not depend upon intensity alone for its effect. The biological significance of the call gives it power far beyond that conferred merely by high intensity.

It may be that birds will cease responding to warning sounds. Only long-range tests will show whether this is the case with gulls. Tests with permanently installed, automatically repeating tape players are planned. If habituation to the alarm call sets in, a shift to the attractive call, broadcast from some spot away from the area to be cleared, may give the desired result.

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10. Authorized for publication as paper No. 1918 in the Journal Series of the Pennsylvania Agricultural Experiment Station. This work was sponsored in part by the U.S. Air Force by the Aero-Medical Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio, under contract No. AF 33(038)-786. The studies were carried out at the Mount Desert Island Biological Laboratory, Salisbury Cove, Me.

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Behavior of Two Species of Worms in the Same Maze

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Yerkes (*1*) demonstrated that, in the course of learning a T-maze, the manure worm *Allolobophora foetida* (*2*) learned an avoidance response to stimuli in close spatial contiguity to noxious stimulation. Yerkes interpreted this result as being indicative of association of stimuli and further concluded that learning in worms could be adequately described in those terms. However, in a recent experiment, Robinson (*3*) found that the earthworm, *Lumbricus terrestris*, exhibited a generalized avoidance to many maze stimuli remote from noxious stimulation under comparable conditions. Robinson criticized Yerkes' conclusion about association of stimuli, and suggested that there are two factors in the learning of a T-maze by annelids: generalized avoidance and correct turning. The problem at issue in this report is whether or not the results of Robinson's investigation with *L. terrestris* are an adequate basis on which to evaluate Yerkes' study with another species of annelid.

Two species of worms were observed with respect

to avoidance behavior in a single-unit T-maze. The two species were *L. terrestris,* an earthworm, and *Eisenia foetida,* a manure worm. Fourteen *Lumbricus* and eight *Eisenia* were run to a criterion of 10 consecutive errorless trials (trials without shock).

The apparatus in the experiment was five simple T-mazes, the stems of which were 8 in. long and each arm was 4 in. long. The alleys were ½ in. wide and ½ in. deep. There was a grid consisting of two No. 18 (B&S) copper bell wires placed ¼ in. from each other. The nearest wire was 2 in. from the choice point in the right arm. The magnitude of shock was 15 ma at 7.4 v. A piece of 0/0 sandpaper 1 cm by ½ in. was placed 1 cm from the grid on the choice-point side. There was an exit tube at the end of the left arm of the maze. The exit tube was 6 in. long and had a groove ½ in. by ½ in. milled into it. The exit tube was covered with a piece of wood. The floor of the exit tube and the maze were covered with strips of paper towel that were kept moist with biological water.

The experiment was conducted in a dimly illuminated room. With the exception of a white strip 3 ft wide at the bottom of the wall, the walls and ceiling of the room were painted black. Illumination was provided by four 60-w incandescent bulbs placed in a line parallel to the maze stems. The lights were placed so that the nearest maze was 3 ft from them and the farthest was 9 ft.

The procedure was to remove a worm from its glass dish and place it in a maze. If the worm did not start to crawl readily, it was stroked with a camel's-hair brush. A trial ended when the worm had crawled into the exit tube either with or without shock. The worm was allowed to remain in the exit tube for approximately 20 min before the next trial began. Ten trials were given every other day. When a day's trials had ended, the worm was removed from the maze and placed in a refrigerator maintained at 7°C.

The mean number of trials to the criterion of 10 consecutive errorless trials was 60.5 for *L. terrestris* and 69 for *E. foetida.* A test of the significance of the difference between means indicated that there was no reason to reject the hypothesis that there is no difference.

An important difference was noted in the avoidance behavior of the two species of worms. *L. terrestris* gave avoidance responses to the whole maze, including the stem, as evidenced by backing out of the maze and increased response latency. These first signs of avoidance began between trials 30 and 50. On the other hand, *E. foetida* gave avoidance responses to only a limited circumstance, that is, by moving more slowly only when it was in contact with the sandpaper. In both cases it is clear that the avoidance behavior exhibited is learned, since it appears only after considerable experience in the maze.

It would be misleading to point only to the differences in avoidance behavior without noting one important similarity between the species. Animals of both species would occasionally make contact with the sandpaper and turn around with the pivotal point on the sandpaper rather than make contact and retreat. This turning response is not tropistic and is extremely unstable. The evidence against the response being tropistic is that the worms would cross the sandpaper readily prior to being shocked a few times. It appears to be unstable because it would appear around the 15th trial and might not appear in any other contacts with the sandpaper.

The finding that *L. terrestris* avoids maze cues remote from the noxious stimulation is the same as the result Robinson obtained with the same species. Similarly, the finding of specific avoidance of stimuli in close spatial contiguity to the source of noxious stimulation by *E. foetida* is in accord with what Yerkes said about that species. Consequently, Robinson's experiment with *Lumbricus* is not a proper basis for his criticism of Yerkes' study in which *Eisenia* was used as the experimental animal.

The results of this study suggest that the problem at issue is not whether a two-factor theory is required to account for learning in worms but rather the proper use of species as an experimental condition. The most satisfactory rule that can be stated at present is: The behavior of different species must be regarded as different until it is proved to be the same. Thus, if that rule is accepted, species would constitute a relevant condition in the comparison, control, and evaluation of behavioral data.

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22 November 1954.

Succinic Dehydrogenase Activity in the Goldfish Gill

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Succinic dehydrogenase has been demonstrated chemically in the rat kidney by Handley and Lavik (*1*). Mustakallio and Telkkä (*2*) have localized this enzyme histochemically in the kidney tubule. The former authors have shown that mercurial diuretics significantly depress total succinic dehydrogenase activity and have suggested that this enzyme system may be involved in active reabsorption of sodium chloride and water from the kidney tubule. In the light of this suggestion, it seemed desirable to check for the presence of succinic dehydrogenase in another tissue where active uptake of sodium occurs. Such a tissue is readily available in the gills of goldfish, which have been shown by Krogh (*3*), Meyer (*4*), and others to transport the sodium ion against a diffusion gradient.

Table 1. Oxygen uptake by excised goldfish gills in succinate, sucrose, and succinate plus mercuric chloride substrates (microliter of O_2 per milligram of dry weight of gills).

Intervals	Series I: Succinate substrate (avg. of 35 fish ± S.E.$_m$)	Series I: Sucrose substrate (avg. of 11 fish ± S.E.$_m$)	Series II: Succinate plus $10^{-5}M$ $HgCl_2$ substrate (avg. of 12 fish ± S.E.$_m$)	Series III: Succinate plus $10^{-3}M$ $HgCl_2$ substrate (avg. of 12 fish ± S.E.$_m$)
30 min	1.99 ± 0.21	0.23 ± 0.14	2.20 ± 0.32	1.18 ± 0.14
60 min	3.86 ± 0.22	.41 ± 0.14	3.71 ± 0.42	1.87 ± 0.21
90 min	5.53 ± 0.26	.71 ± 0.26	5.09 ± 0.50	2.24 ± 0.22
"P" for 90-min interval		< .001	0.297	< 0.001

Thirty-five goldfish obtained from a commercial hatchery were used in these experiments. Filaments stripped from excised gill arches were used for experimental tissues. Each fish served as its own control. The Warburg apparatus was used to determine succinic dehydrogenase activity by the method suggested by Umbreit, Burris, and Stauffer (*5*). Three milliliters of substrate were used in each flask.

In series I, sucrose was substituted for sodium succinate as a substrate. In series II and III, sodium succinate was used as a substrate. In series II, mercuric chloride was made up in succinate substrate and placed in the side arm of the flask. Its concentration was such that when tipped into the flask it produced a concentration of $10^{-5}M$ mercuric chloride for the entire substrate. The same procedure was followed for series III except that the final concentration of mercuric chloride in the substrate was $10^{-3}M$. In series II and III, unaltered succinate substrate was tipped into the control flasks. After 20 min for equilibration, readings were taken at 0-, 30-, 60- and 90-min intervals. All tip-ins were made at the 30-min interval. Calculations are based on the percentage dry weight of the gill tissue.

The results of these experiments are presented in Table 1. The first column gives the average oxygen uptake for all gills run in the pure succinate substrate. The "P" values presented are for the 90-min interval and compare the oxygen uptake in the succinate substrate with oxygen uptake in the sucrose substrate, succinate plus $10^{-5}M$ mercuric chloride substrate, and succinate plus $10^{-3}M$ mercuric chloride substrate, respectively.

The significantly greater uptake of oxygen by gill filaments in a succinate substrate (5.53 µlit of O_2 per milligram of dry weight) as compared with the uptake in sucrose substrate (0.71 µlit of O_2 per milligram of dry weight) at the 90-min interval is considered proof of the presence of succinic dehydrogenase in the gills of goldfish. According to Barron and Kalnitzky (*6*), mercuric chloride inhibits the activity of this system by combining with essential sulfhydryl groups. Such an inhibition was found to occur when $10^{-3}M$ mercuric chloride was added to the substrate (series III). The uptake of oxygen was reduced 59.5 percent. Since Meyer (*7*) has inhibited active uptake of sodium in the goldfish gill with mercuric chloride, it is suggested that this work offers additional evidence in favor of the theory that succinic dehydrogenase is involved in active sodium transportation.

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29 November 1954.

Determination and Inheritance of Nicotine to Nornicotine Conversion in Tobacco

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The presence of a genetic factor in certain low-nicotine strains of tobacco controlling conversion of nicotine to nornicotine during air curing has been reported by Valleau (*1*). The change of a portion of the nicotine to nornicotine reduces the alkaloid content of the smoke, since the transfer of nornicotine into the smoke is less than one-fourth of the transfer for nicotine (*2*). Utilization of this genetic factor in commercial varieties could be advantageous, since, with acreage control, overfertilization of burley tobacco, in an effort to increase yields, has tended to raise the nicotine content of some crops to an undesirable level.

The development of the following paper chromatography method, based in part on the work of others (*3*), has permitted extensive investigations (*4*). In this method, 1 g of a finely ground tobacco sample was placed in a 15-ml centrifuge tube. Five milliliters

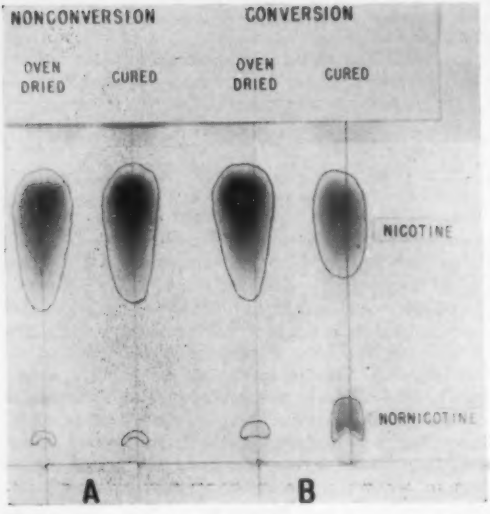

Fig. 1. Chromatogram of oven-dried and cured samples from conversion and nonconversion plants.

of an extracting solution (chloroform-methanol-water, 15:9:1 by volume, saturated with sodium hydroxide) was added and the mixture was stirred thoroughly. After 30 min, the stirring was repeated and the samples were centrifuged. Ten microliters of each extract was spotted at 2-cm intervals, 2 cm from one edge, on 23- by 28-cm pieces of Whatman No. 1 filter paper that had been impregnated with a 0.2*M* citric acid solution adjusted to a *p*H of 5.65 with sodium hydroxide. The chromatograms were developed overnight with tertiary amyl alcohol saturated with water and β-naphthylamine, using an ascending technique. Before being dried, the chromatograms were placed in an acetic acid atmosphere. After drying they were briefly exposed to ammonia and then placed in a cyanogen bromide vapor chamber for color formation. The alkaloids appeared as brightly colored orange and red spots. The Rf value of nicotine was 0.55 and of nornicotine 0.11.

Representative chromatograms of nonconversion and conversion plants are illustrated in Fig. 1. Little, if any, change in nicotine or nornicotine occurs during air-curing of nonconversion strains (*A*). The nicotine spots of air-cured samples of conversion lines are smaller and less intense and the nornicotine spots are larger and more intense (*B*) than the comparable oven-dried samples, indicating that during curing nicotine was changed to nornicotine.

Previous segregation data of a heterozygous line indicated that conversion was controlled by a single dominant gene. Additional data were obtained from crosses made between a low-nicotine true-breeding conversion line and a true-breeding nonconversion high-nicotine line. The F_1 generation was grown in the greenhouse and backcrossed to the parent lines. The F_2 generation and backcross plants were grown in the field. Samples consisting of four leaves from each plant were taken from the greenhouse plants at maturity and from young field plants. Two leaves were immediately dried at 70°C in a forced-draft oven and the other two were air cured.

The results obtained when progenies were tested for conversion are given in Table 1. These results furnish further proof that conversion of nicotine to nornicotine during curing is controlled by a single dominant gene. The one F_1 plant and the two backcross plants without conversion could have arisen from pollen contamination during crossing.

The rapidity of the paper chromatography procedure also permitted an extensive study of the alkaloids of tobacco varieties. In a preliminary study of 36 individual plants of Ky 16 burley, nine plants were found to carry the conversion factor, and heterozygosity with respect to the nicotine level was indicated. An additional study was conducted, using 20 plants from each of 100 single plant lines of Ky 16. Homozygous and heterozygous lines for conversion and the extent of conversion were found. Some of these averaged 25 to 54 percent less nicotine than the average of the 100 lines. Conversion has also been found in other burley tobacco and in flue-cured varieties, and a widespread distribution of the conversion factor in *Nicotiana tabacum* is indicated.

Table 1. Data obtained from plants of the F_1, F_2, and BC_1 generations and the expected numbers assuming a single dominant gene *C* to control the conversion of nicotine to nornicotine.

Class of plants	Number of plants			
	Conversion (*CC or Cc*)		Nonconversion (*cc*)	
	Expected	Obtained	Expected	Obtained
F_1 *cc* × *CC*	36	35	0	1
F_2 *cc* × *CC*	120	114	40	46
BC_1 *Cc* × *cc*	30	32	30	28
BC_1 *Cc* × *CC*	50	48	0	2

Considering the heterozygosity of burley tobacco with respect to alkaloids, it seems probable that varieties will be heterozygous with respect to other chemical constituents. If this proves to be true, there is an opportunity to improve present varieties with respect to aroma, taste, and general smoking qualities by selection.

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17 November 1954.

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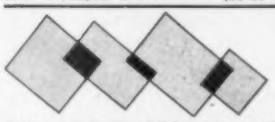

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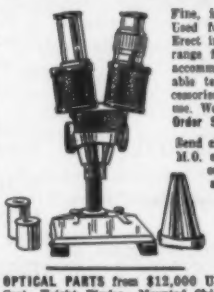

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Edited by Harry Sobotka

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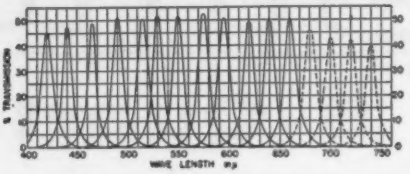

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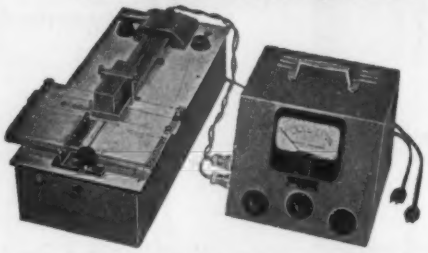

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Control of Unclassified Information

LAST 5 November the Secretary of Commerce announced the establishment of an Office of Strategic Information. The new office was created at the direction of the President and on the recommendation of the National Security Council. In his announcement, Secretary of Commerce Sinclair Weeks explained that

> This office will provide a central location within the Government which will work with the business community in voluntary efforts to prevent unclassified strategic data from being made available to those foreign nations which might use such data in a manner harmful to the defense interests of the United States. . . . Such watchfulness would not take the form of censorship. It would instead be a matter of exercising intelligent, reasonable precaution to make sure that in the necessarily free exchange of scientific information we do not provide nations whose interests are inimical to our own with material which they could some day use against us.

Editors and publishers have in some cases accepted the new office with a "wait-and-see" attitude in order to allow time for the public announcement of operating policies and of classes of information to be affected. Such clarification has not yet appeared. Others have been quick to point out faults in the scheme, for it has reminded them unpleasantly of their censorship problems during World War II. At that time editors were at first required to submit for official clearance galley proofs of almost all unclassified technical articles. For lack of qualified people to evaluate these papers, this program was soon succeeded by a "voluntary" one that placed responsibility for publication on the editor. Since editors could, and did, get competent assistance from their editorial advisers, this second system was reasonably satisfactory.

However, in 1951, following a study by the Interdepartmental Committee on Internal Security, a committee of the National Security Council, a service was established in the Department of Commerce's Office of Technical Service that was to provide a central organization to which businessmen, scientists, public officials, and private citizens might write for guidance on whether or not specific unclassified technologic information should be released. Applicants were under no obligation to follow the advice given. After an initial 100 to 150 inquiries, the number dwindled to only 10 to 12 a year—hardly a successful program! And yet, the new Office of Strategic Information seems to have objectives that are identical with those of the earlier agency.

The major critic of the Office of Strategic Information has been the Freedom of Information Committee of the American Society of Newspaper Editors. Chairman J. R. Wiggins has pointed out that there is no definition of what information is both unclassified and of strategic importance; that the office constitutes a serious threat to the freedom of information; that Director Honaman's suggestion that important information could be withheld from general publication but given privately to the relatively small number of people to whom its possession would be valuable would open the way to flagrant discrimination in giving technical information to one industrial company and not to another; that guidance directives, whatever their legal force, will quickly acquire the practical force of regulations and rules; that no publisher will wish to deny requests for "cooperation"; that the project will lead to a "species of censorship of the most offensive kind."

Chief purpose of the office seems to be to screen technical and industrial know-how rather than basic scientific findings. Yet scientists will want to watch developments closely, as editors have been doing, because the types of information affected have not yet been described and because the adoption of the principle involved might serve as a precedent for enlarged efforts to control the publication of scientific and technical information.—D. W., B. P.

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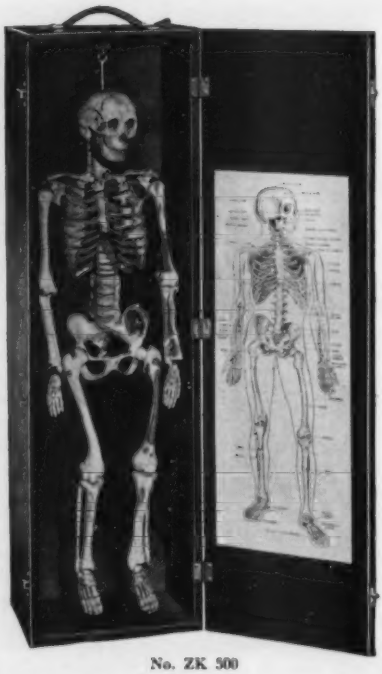

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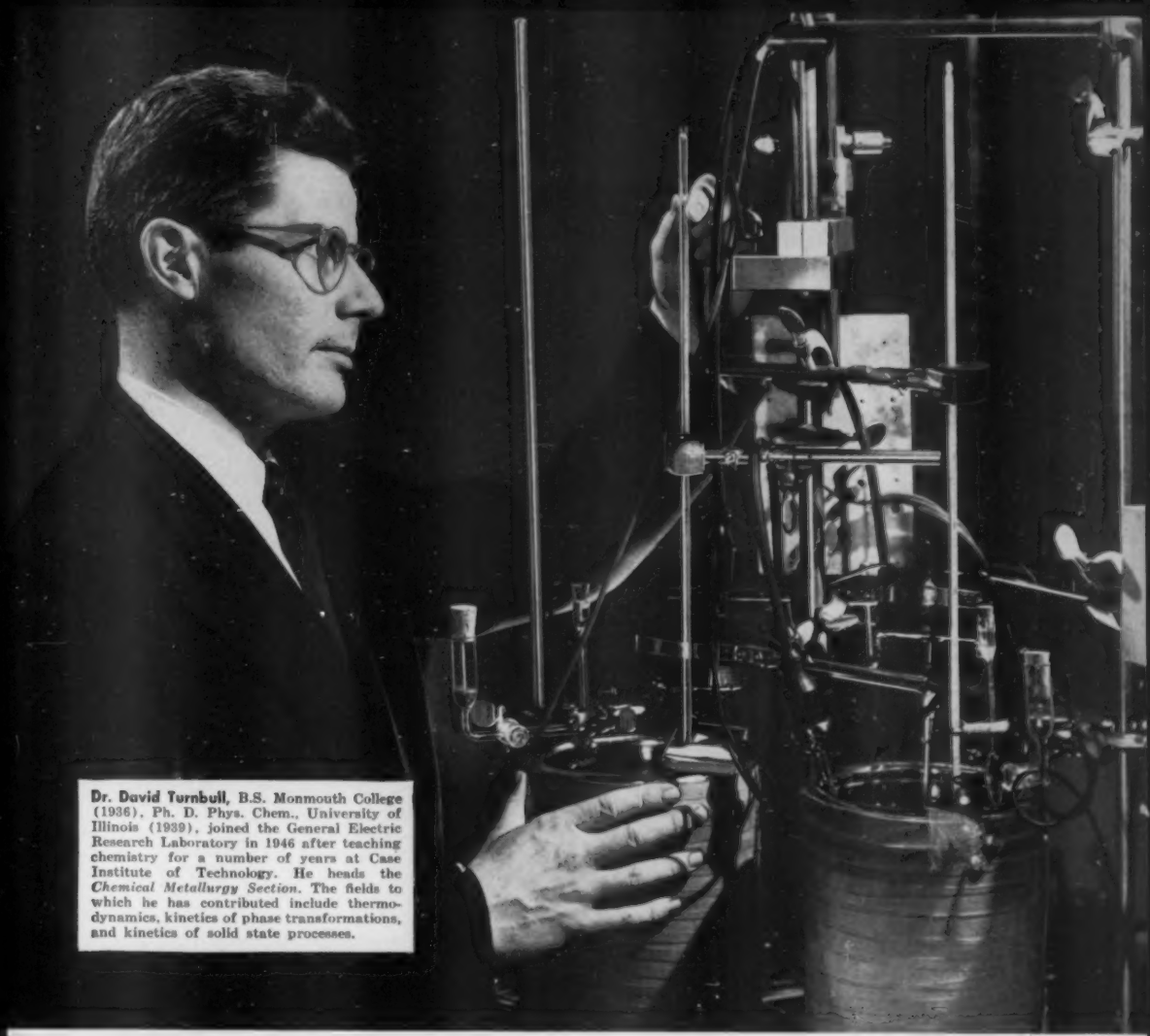

Dr. David Turnbull, B.S. Monmouth College (1936), Ph. D. Phys. Chem., University of Illinois (1939), joined the General Electric Research Laboratory in 1946 after teaching chemistry for a number of years at Case Institute of Technology. He heads the *Chemical Metallurgy Section*. The fields to which he has contributed include thermodynamics, kinetics of phase transformations, and kinetics of solid state processes.

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3–6. American Astronomical Soc., Princeton, N.J. (C. M. Huffer, Washburn Observatory, Madison 6, Wis.)

3–7. American College Personnel Assoc., Chicago, Ill. (C. Evans, Univ. of Indiana, Bloomington.)

4. American Educational Research Assoc., Cleveland, Ohio. (F. W. Hubbard, 1201 16 St., NW, Washington, 6, D.C.)

4–5. Atomic Industry Conf., San Francisco, Calif. (Atomic Industrial Forum, 260 Madison Ave., New York, N.Y.; or Stanford Research Inst., Stanford, Calif.)

4–5. Histochemical Soc. Symposium, Philadelphia, Pa. (A. B. Novikoff, Waldemar Medical Research Foundation, Port Washington, N.Y.)

4–5. National Gastrointestinal Cancer Conf., sixth, New York, N.Y. (Morris K. Barrett, National Institutes of Health, Bethesda 14, Md.)

4–6. American Assoc. of Physical Anthropologists, Philadelphia, Pa. (J. L. Angel, Jefferson Medical College, 307 S. 11 St., Philadelphia 7.)

5. Microcirculatory Conf. for Physiology and Pathology, 2nd, sponsored by American Association of Anatomists, Philadelphia, Pa. (G. P. Fulton, College of Liberal Arts, Boston Univ., 725 Commonwealth Ave., Boston 15.)

5. Tissue Culture Assoc., annual, Philadelphia, Pa. (M. R. Murray, TCA, College of Physicians and Surgeons, New York 32, N.Y.)

5–7. Radio Technical Commission for Aeronautics, spring assembly meeting, Los Angeles, Calif. (RTCA, Room 2036, Building T-5, 16th and Constitution Ave., NW, Washington 25, D.C.)

6–8. American Assoc. of Anatomists, Philadelphia, Pa. (N. L. Hoerr, 2109 Adelbert Rd., Cleveland 6, Ohio.)

8–9. Pennsylvania Academy of Science, Philadelphia, Pa. (K. Dearolf, Public Museum and Art Gallery, Reading.)

9. South Carolina Acad. of Science, Columbia, S.C. (H. W. Freeman, Univ. of South Carolina, Columbia.)

10–15. American Inst. of Homeopathy, Washington, D.C. (W. R. Huntsman, AIH, 1601 Chestnut St., Philadelphia 3, Pa.)

10–15. American Inst. of Nutrition, San Francisco, Calif. (R. W. Engel, Dept. of Biochemistry and Nutrition, Virginia Polytechnic Inst., Blacksburg.)

10–15. American Soc. for Pharmacology and Experimental Therapeutics, San Francisco, Calif. (C. C. Pfeiffer, Emory Univ. School of Medicine, Emory Univ., Ga.)

10–15. Federation of American Societies for Experimental Biology, San Francisco, Calif. (M. O. Lee, 2101 Constitution Ave., Washington 25, D.C.)

10–16. American Physiological Soc., San Francisco, Calif. (M. O. Lee, 2101 Constitution Ave., Washington 25.)

10–16. American Soc. for Experimental Pathology, San Francisco, Calif. (C. C. Erickson, Inst. of Pathology, Univ. of Tennessee, 858 Madison Ave., Memphis.)

10–18. International Soc. of Urology, Athens, Greece. (Z. Kairis, 25 Voucourestiou St., Athens.)

11–14. Assoc. of American Geographers, annual, Memphis, Tenn. (B. W. Adkinson, Library of Congress, Washington 25, D.C.)

11–15. American Assoc. of Immunologists, annual, San Francisco, Calif. (F. S. Cheever, Graduate School of Public Health, Univ. of Pittsburgh, Pittsburgh 13.)

(See issue of 18 February for more comprehensive listings.)

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